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Estimation of the Daily Consumption of Food by Fish in the North Sea in Each Quarter of the Year

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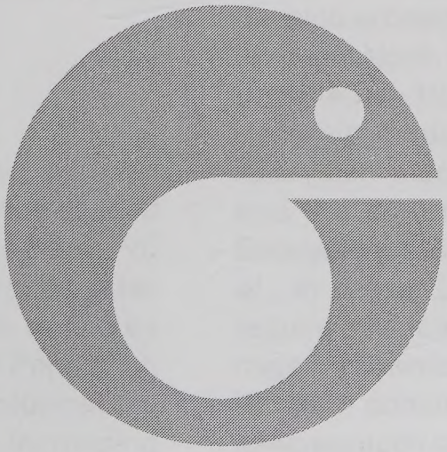

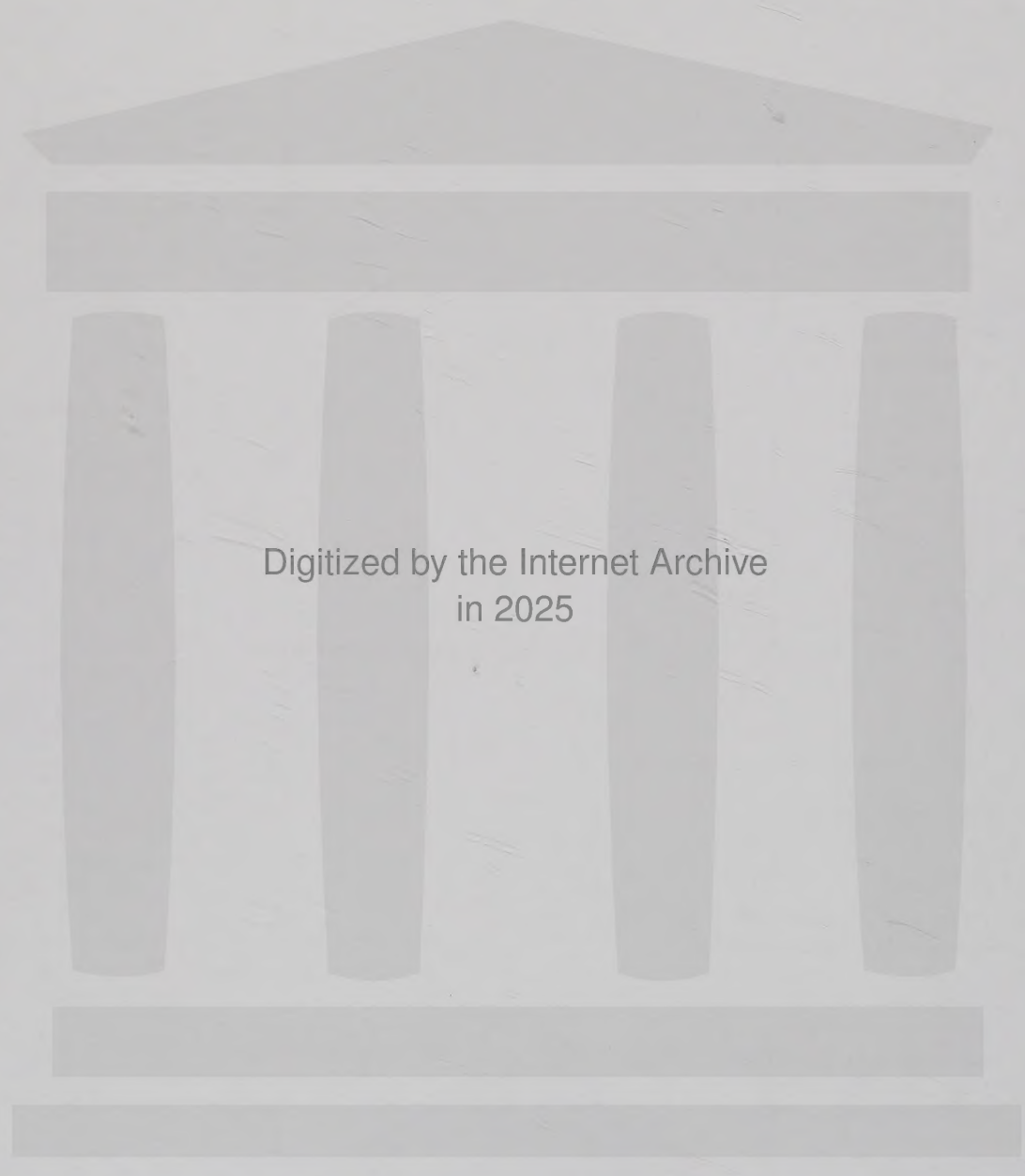

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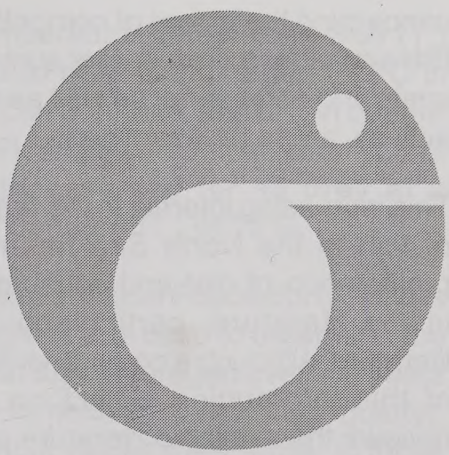
Estimation of the Daily Consumption of Food by Fish in the North Sea in Each Quarter of the Year



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Summary

In this paper the fish of the North Sea are assigned to one of four life-history guilds. The various prey recorded in fish dietary studies are assigned to one of 12 life-history guilds (which also includes the four fish guilds). The daily consumption of each prey guild by each predator guild is estimated for the whole North Sea for each quarter of the year. Summing across quarters, an estimate of the total annual consumption of food by North Sea fish of over 55 million tonnes is obtained. Nearly 11 million tonnes of this food is fish, which is approximately equal to the total fish standing crop at any one time. These results are briefly discussed in relation with other studies and the question as to how such quantities of food can be supplied is raised. However, the principal purpose of this report is to detail how these estimates of food consumption by fish were derived.

Introduction

Recent years have seen a marked increase in interest in the diets and quantities of food consumed by fish in the North Sea. For example, variation in the consumption rates of fish prey by fish predators is a key component of Multi-Species Virtual Population Analysis (MSVPA). Using this information, MSVPA examines the effects of increasing prey abundance on predator populations and vice versa. Such an approach allows the "knock-on" effects of fisheries-induced changes in the abundance of particular species to be investigated.

To date MSVPA has been restricted to examining the impact of only a few commercially important predators on a few commercially important prey; it thus provides a rather limited view of the North Sea ecosystem. For other types of question fish feeding interactions must be viewed in a wider context. For example, it is legitimate to ask how fisheries-induced changes in the populations of commercial fish species affect trophic interactions, not only within the fish guild, but also between fish and their benthic and planktonic invertebrate prey (eg Anon, 1991)? One approach to such questions is to develop ecosystem models. Static models, for example North Sea food web energy budgets (eg Steele, 1974; Jones 1982; 1984), and dynamic models, such as the North Sea ecosystem model (Andersen and Ursin, 1977) and the current European Regional Seas Ecosystem Model (ERSEM, Broekhuizen *et al.*, in press; Bryant *et al.*, in press), both require information on the total exchange of material between fish and lower trophic levels. Rates of consumption of certain pelagic fish species, such as sandeels and sprats, by fish predators are also of interest if questions

concerning the extent of competition between fish and other top predators such as seabirds, seals and cetaceans, as well as man's fishing activity, are to be examined.

This increasing interest in the feeding ecology of fish in the North Sea has resulted in a proliferation of diet and consumption papers in the literature, particularly in the ICES literature, although a comprehensive synthesis of this information is lacking. This paper reviews the available literature and draws on the most relevant and suitable papers to estimate the total daily consumption of all types of prey by the total fish assemblage of the North Sea in each quarter of the year.

General Approach

In this paper, fish species were assigned to one of four fish guilds; Demersal piscivores, Demersal benthivores, Pelagic piscivores and Pelagic planktivores (see Appendix I for details). Diet and consumption rate data, obtained from stomach analysis, were examined for between two and four species in each fish guild. All recorded prey items were assigned to one of 12 prey guilds - the four fish guilds mentioned above plus, mega-benthos, macro-benthos carnivores, macro-benthos deposit feeders, macro-benthos filter feeders, meroplankton, meso-zooplankton carnivores, meso-zooplankton omnivores, and phytoplankton flagellates (see Appendix II for details).

Daily food rations were calculated, where possible, by applying suitable digestion models to stomach contents weight data. If stomach weight information was not available, published daily rations were used. As far as possible, daily rations were estimated by predator age group, and for each quarter of the year. Thus seasonal variation in predator foraging activity, the relationship between predator size (age) and diet, and the effect of varying water temperature on digestion rates were all taken into account.

Using the published diet information (as a percentage wet weight contribution of each prey to the total diet), the daily ration could be partitioned between the various prey consumed. Unidentified items were excluded and the contributions to the diet of all identified items were readjusted to bring the total back to 100%. Incompletely identified prey were redistributed according to the identified prey within the same taxon, eg unidentified fish were assigned to species according to the relative contribution of fully identified fish prey. Daily food ration estimates were converted to coefficients of daily food consumption as a percentage of predator weight. Thus the total daily consumption of each prey by a particular predator species could be determined from the estimated biomass of the predator.

The total daily consumption of each prey guild by each fish guild was calculated by summing consumption of each prey across the predators for which data were available within a predator guild, then raising these results to account for the total biomass of fish in each guild.

Fish Guild Biomass

Three studies have estimated the total biomass of fish in the North Sea; Yang (1982) for 1 January 1977 and 1978, Sparholt (1990) for 1 January and 1 October averaged over the years 1983 to 1985 and Daan *et al.* (1990) covering the period 1977 to 1986. Where comparable, the results of all three studies are quite similar. For the purpose of this document I have used Sparholt's biomass estimates for the first and fourth quarters of the year. Constant rates of increase or decrease have then been assumed to estimate biomass for the second and third quarters. Table 1 shows quarterly variation in the biomass of each of the species for which diet and daily consumption rate data were available, and the guilds to which these species belong. The biomass of fish belonging to commercially exploited and non-exploited species is given, as well as the total biomass in each fish guild. The percentages of the total guild biomass which is not commercially exploited and for which diet and consumption data are known are also indicated. Appendix I lists all the species for which Sparholt (1990) estimated a biomass and the fish guild to which they have been assigned.

Diet and Daily Food Consumption of Demersal Piscivores

The four commercial gadoid species, cod, haddock, whiting and saithe, made up between 73% and 80% of the total biomass of the Demersal piscivore predator guild (Table 1). Diet composition data for each of these species were obtained from Daan (1989). The diets of cod, haddock and whiting were described for each quarter of the year and by age group (Tables 2, 3 and 4). Saithe diet was described by length group in summer and winter only (Table 5a). Age-length keys for saithe (Table 5b; Daan, 1989) were used to convert diet at length to diet at age. The summer diet composition was used for quarters 2 and 3, while the winter diet was used for quarters 1 and 4 (Table 5c). The diet of "0" group saithe in quarters 3 and 4 was assumed to be identical to that of "1" group fish. No data for "0" group whiting were presented in Daan (1989). Information for this age group in quarters 3 and 4 was obtained from Hislop *et al.* (1983). The quarter 3 "0" group whiting diet given in this paper reflected the diet of "0" group whiting in the pelagic phase (Robb, 1981; Robb and Hislop, 1980) except that copepods were not included. To make up for this exclusion, prey items listed as "unidentified crustacea" taken by "0" group whiting in quarters 3 and 4 (Hislop *et al.*, 1983) were all considered to be copepods (Table 4). Diet data for "0" group cod and haddock were included in Daan (1989). Daan (1989) specifically listed only the commercial fish species taken by these predators. The non-commercial fish component of the diet was partitioned to species with reference to Hislop *et al.* (1991) in the case of whiting, Daan (1973) and Vea Salvanes (1986) in the case of cod, and Cranmer (1986) in the case of haddock. In the case of saithe, non-commercial fish were arbitrarily assigned to demersal piscivores and pelagic planktivores in the ratio 0.8:0.2.

Daily food consumption rates ($g.day^{-1}$) were calculated using the mean stomach weight at age in each quarter (w), given by Daan (1989), and applying Jones' (1974) digestion model:

$$24 * w^{0.46} * (L/40)^{1.4} * Q * 10^{0.35(To-Tr)}$$

The water temperature in the North Sea (T_o) was assumed to be 6°C in quarter 1, 7°C in quarter 2, 10°C in quarter 3, and 8°C in quarter 4 (Daan 1989). A digestion coefficient (Q) of 0.2 $g.hr^{-1}$ was assumed for all prey at a reference temperature (T_r) of 12°C.

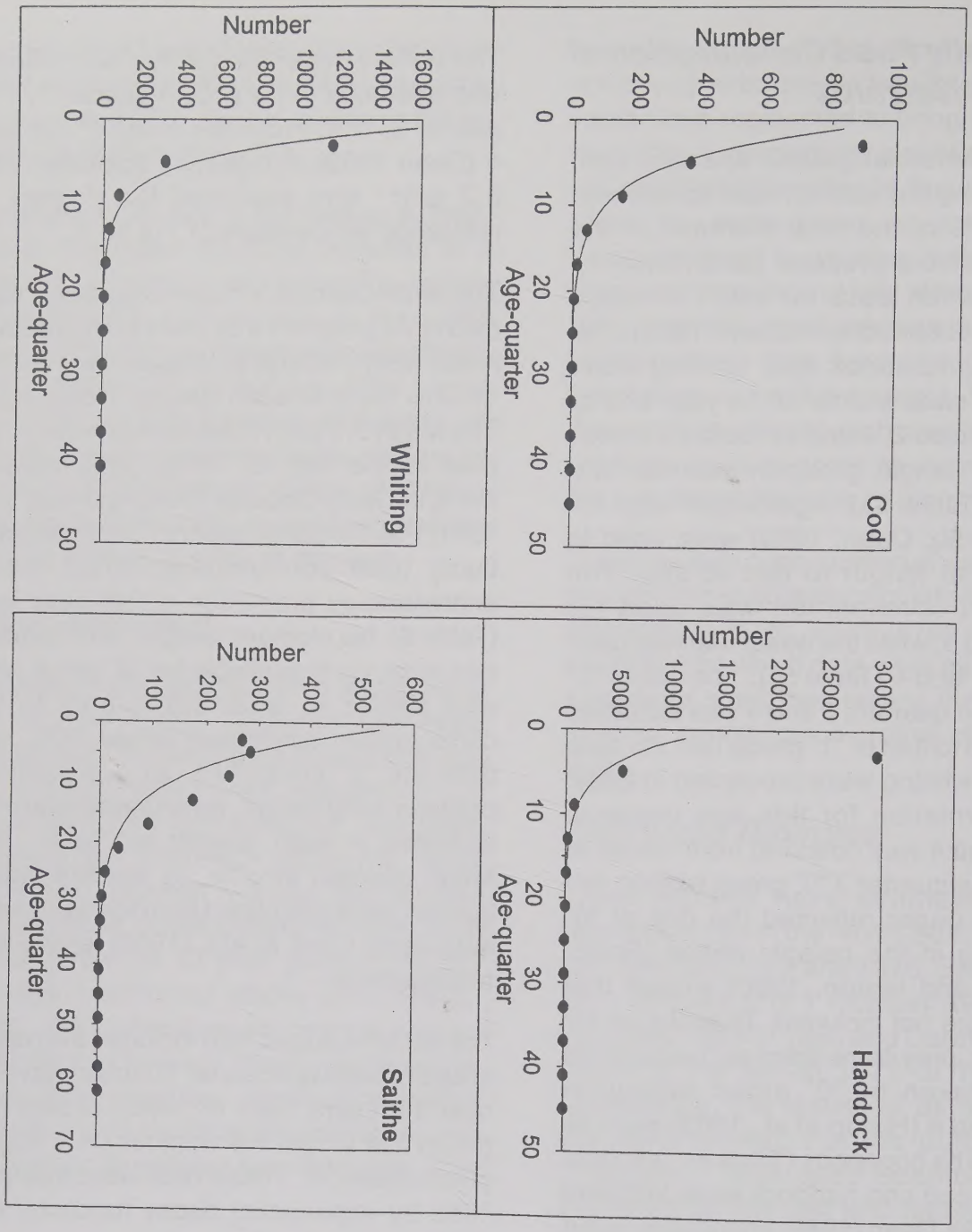
The Multi-Species Virtual Population Analysis (MSVPA) program was used to determine the mean weight at age (averaged over the years 1983 to 1989) for each species in each quarter. The MSVPA input values were similar to those used for the "key run" of the 1990 meeting of the ICES Multi-Species Working Group (Anon, 1991; P.A. Kunzlik, Personal Communication). Daily food consumption could then be expressed as proportion of fish body weight (Table 6). No stomach weight, or consumption rate data, were available for "0" group whiting and saithe in quarters 3 and 4. Daily consumption coefficient values 20% higher than the "1" group fish, as a proportion of predator body weight, were therefore arbitrarily assigned in each quarter (eg Daan, 1973). Mean predator lengths, by species, age and quarter, were calculated from the weight at age data using Coull *et al's.* (1989) length-weight relationships.

The MSVPA output also included the numbers at age of each species on 1 January (averaged over the years 1983 to 1988), except for "0" group fish where the number on 1 July was given (Table 7). These data were adequately fitted by exponential decay functions of the form:

$$\text{Stock size} = 10^{a} * 10^{b * \text{age-quarter}}$$

with time units in quarter years (age-quarter) rather than years (Fig. 1). Thus the July count of "0" group provided a value for age-quarter 3, the January count of "1" group provided a value for age-quarter 5, the January count of "2" group provided a value for age-quarter 9, and so on. These functions were used to provide estimates of the numbers of each gadoid species, by age, in each quarter of the year (Table 8) using the following formula:

$$\text{age-quarter} = (4 * \text{fish year class}) + \text{seasonal quarter}.$$



Species	10^a value	b value
Cod	1066002	-0.10489
Haddock	14964975	-0.12514
Whiting	21589123	-0.13727
Saithe	621962	-0.06692

Figure 1. Decay functions for four gadoid species in the Demersal Piscivore ERSEM predator group.

Straight line fit was obtained by plotting logarithm of the y variate, numbers; function is therefore given by:

$$y = 10^a . 10^{bx}$$

where x is age in number of quarters and quarter 1 is the first quarter of the year when fish emerged as "0" group.

Multiplying these quarterly numbers at age by the mean weight at age for each species in each seasonal quarter (see Table 6) gives estimates of species biomass by age and quarter (Table 9). The Sparholt (1990) derived quarterly total biomass estimates for each species (ie Table 1) were then partitioned by age in the same ratios (Table 10). Total daily consumption of food (tonnes.day^{-1}), by species, age and quarter, was then estimated (Table 11) by multiplying the biomass estimates (by species, age and quarter; see Table 10) and the daily ration as a proportion of body weight (by species, age and quarter; see Table 6). Knowing the diet of each of these gadoid fish, by age and quarter (see Tables 2-5), the daily consumption (tonnes.day^{-1}) of their various prey was determined (Tables 12-15).

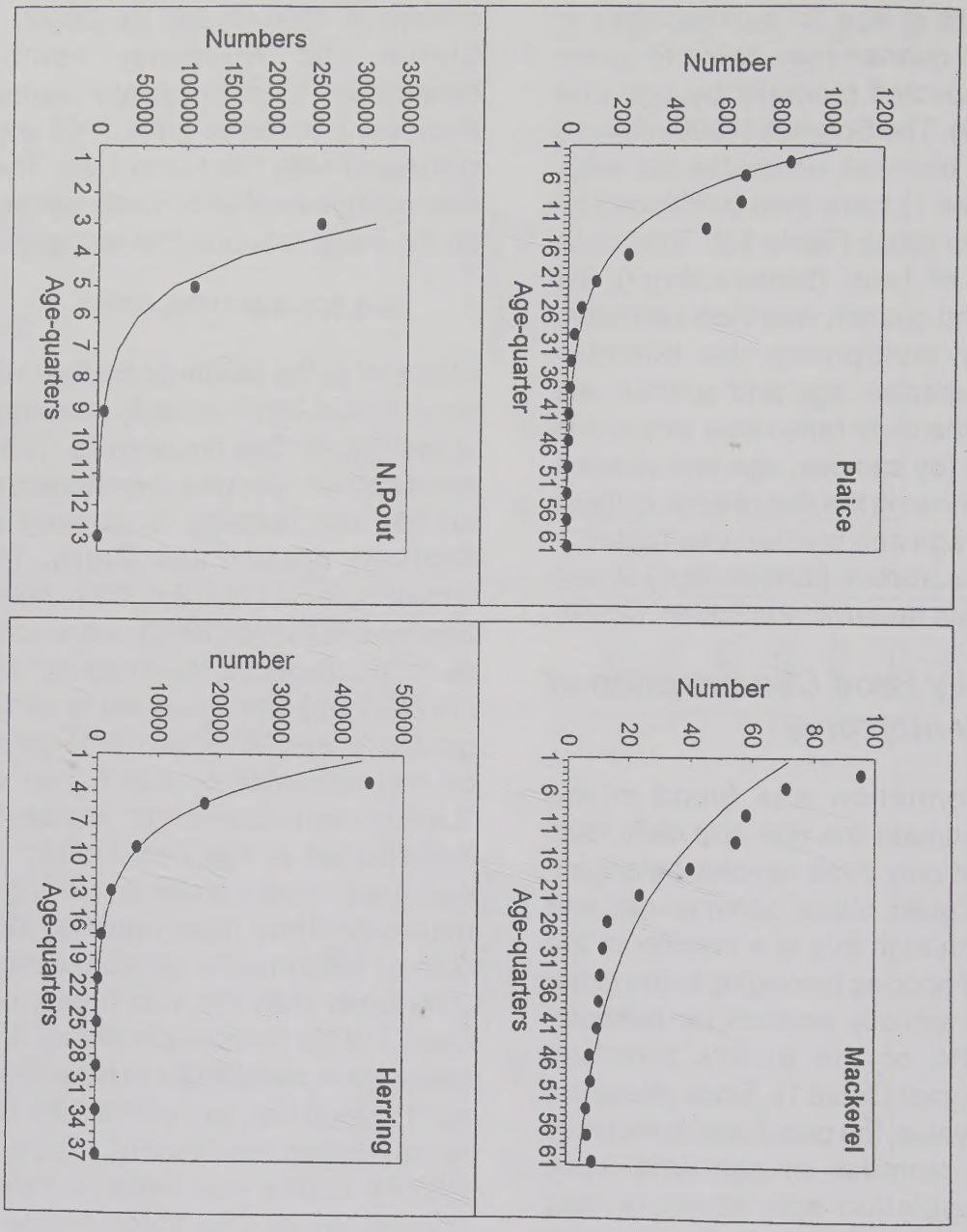
Diet and Daily Food Consumption of Demersal Benthivores

Sufficient information was found in the literature to estimate the diet and daily food consumption of only three species belonging to this predator guild; plaice, common dab and lemon sole. Although this is a fraction of the total number of species belonging to the guild, these species actually account for between 78% and 86% of the guild's biomass throughout the year (Table 1). Since plaice are of commercial value, the population is routinely assessed so biomass at age data were available. Population age structure was therefore taken into account in estimating prey consumption by plaice; daily consumption was determined in a manner similar to that employed for the gadoids above. This was not the case for lemon sole and common dab where no biomass at age data could be found. Population diets and consumption rates were therefore used.

Basimi and Grove (1985) present data on the diet and daily consumption rates (%BW.day^{-1}) for plaice of various length in different quarters of the year. This study was carried out in east Anglesey in north Wales, however comparison with work done in the North Sea suggests that the diets in the two regions were broadly similar. Particular prey species may have varied, but in terms of the prey guild to which these prey were assigned there was little difference (Braber and de Groot, 1973; De Clerck and Buseyne, 1989). Water temperature was marginally warmer in east Anglesey in quarters 2 (12.5°C) and 3 (16°C) compared with the North Sea. The function describing the effect of water temperature (T) on the instantaneous rate of digestion (k):

$$k=0.025*W^{0.068}*e^{0.086T}$$

where W is the weight of the fish, was used to convert east Anglesey daily consumption rates to their North Sea equivalents. The quarter 1 consumption rate was then halved to account for fish not feeding in January and early February (Basimi and Grove, 1985). The "small" group (15-19.4 cm), described by Basimi and Grove (1985), were considered to be "1" group plaice, the "medium" sized group (19.5-25 cm) was assumed to consist of age groups "2" and "3", while the "large" group (30-35 cm) consisted of 4 to 6 year old plaice. "Large post-spawning" plaice (>35 cm) included fish of age 7 and older; these were assumed to have a diet consisting of entirely macro-benthos filter feeders (Basimi and Grove, 1985) and a consumption coefficient 20% lower than the 4 to 6 year old fish (eg Daan, 1973). In quarters 3 and 4, "0" group plaice were considered to have the same diet as "1" group fish, but with a 20% higher daily consumption coefficient (Table 16). The MSVPA output was used to determine the proportion of the total plaice biomass belonging to each age grouping in each quarter in the same way as for the gadoid fish (Table 17, Fig. 2). Knowing the biomass of plaice belonging to each age group in each quarter, the total daily consumption of food, and the consumption of each prey type, could then be estimated, by age and quarter (Table 18).



Species	10^a value	b value
Plaice	1142094	-0.04943
Norway pout	2188260000	-0.28185
Mackerel	74596	-0.02048
Herring	54275771	-0.09866

Figure 2. Decay functions for plaice, mackerel, Norway pout and herring.

Straight line fit was obtained by plotting logarithm of the y variate, numbers; function is therefore given by:

$$y = 10^a \cdot 10^{bx}$$

where x is age in number of quarters and quarter 1 is the first quarter of the year when fish emerged as "0" group.

The common dab is one of the most abundant species in the North Sea, consequently its diet has been the subject of several studies. Knust (1986) provides information on seasonal variation in the diet of dab and these data were used for the purposes of this study (Table 19). The diet described by Knust (1986) is broadly similar to diets described by other workers (eg Duineveld and van Noort, 1986); any differences can be explained by variation in habitat type (eg Creutzberg and Duineveld, 1986), depth (eg De Clerck and Torreele, 1988), or distance from shore (eg Braber and de Groot, 1973) of the study area. Lemon sole diet in the North Sea was described by Rae (1956). No major seasonal variation was observed so a fixed diet was assumed throughout the year (Table 20).

To estimate common dab daily consumption rates in each quarter, the digestion model of Gwyther and Grove (1981) was applied to the data of Creutzberg and Duineveld (1986). Creutzberg and Duineveld (1986) stated that an area of 10,000 m^2 supported 80 dab of mean weight 50 g; a total dab biomass of 4,000 g. Annual food consumption by dab was 1.44 g wet weight.m^{-2}.yr^{-1}; an area of 10,000 m^2 therefore supplied 14,400 g food.yr^{-1}, an average daily supply of 39.45 g.day^{-1} over the whole year. The water temperature, averaged over the year, was 7.75°C. Average daily rations in each quarter, taking into account the effect of water temperature on digestion rates, were calculated using Gwyther and Grove's (1981) function relating daily food consumption to water temperature to modify the annual average daily ration value (Table 21: I). These values assume that dab feeding activity is the same in each quarter however, this is not the case (Knust, 1986). The quarterly daily rations were then further modified to account for these differences in feeding activity (Table 21: II). These daily rations are consumed by 4,000 g of dab biomass, thus daily food consumption rates as a percentage of dab biomass could be calculated for each quarter. Daily food consumption by lemon sole as a percentage of predator biomass was assumed to be the same as for common dab, except that the seasonal pattern of feeding activity differed between the two species (Table 21: III, after Rae, 1956). These values were used to modify those consumption rates calculated for dab in each quarter which took only seasonal variation in water temperature into account (eg Table 21:I). The resulting daily food consumption rates, as a percentage of lemon sole biomass, are given in Table 21: III.

Given the biomass of common dab and lemon sole present in the North Sea in each quarter (Table 1), and the daily food consumption rate as a percentage of fish biomass (Table 21), the total quantity of food consumed by these two predators each day can be determined. Further, given the quarterly diet information (Tables 19 and 20), this can be broken down to prey species (Tables 22 and 23).

Diet and Daily Food Consumption of Pelagic Piscivores

This guild comprises only mackerel and horse mackerel (Table 1). Table 24 gives mackerel diet and mean stomach weight, by quarter and age (Daan 1989). The MSVPA output provided mackerel mean weight data by age and quarter. The MSVPA output was also used to determine the proportion of the total Sparholt (1990) mackerel biomass belonging to each age group in each quarter (Table 25, Fig. 2). Daily food consumption was calculated using the digestion model prescribed by Mehl and Westgard (1983a; 1983b):

$$C = f(T) * w * 24,$$

where w is the mean weight of the stomach contents and f(T) is the hourly digestion rate at temperature T given by:

$$f(T) = 0.005 * \exp(0.2 * T)$$

The resulting daily consumption rates (Table 26) were low compared with rates calculated for other species in this study, but they were similar to those calculated by Mehl and Westgard (1983b) for mackerel with similar mean stomach content weights. However, these latter estimates were also considered by the authors to be on the low side. In quarters 3 and 4 "0" group mackerel were arbitrarily assigned daily consumption rates of 0.63%BW.day^{-1} and 0.35%BW.day^{-1}

respectively. Total daily consumption of each prey, by quarter and age group, is given in Table 27.

Being a species currently of little commercial value, variation in the population size, distribution, age structure, diet and food consumption of horse mackerel are not routinely assessed; few feeding data are therefore available. However, horse mackerel can be very numerous in the North Sea, particularly in the summer and autumn; they therefore represent a considerable predatory threat to other fish stocks. Consequently, a Danish study examined the abundance, diet and food consumption of horse mackerel belonging to various length classes off the western Danish coast during the summer period (Dahl and Kirkegaard, 1986, 1987; Kirkegaard *et al.*, 1987). These data were used to estimate the total consumption of each prey type in quarter three as a percentage of the total horse mackerel biomass present in the Danish study area. Assuming the same consumption rate as a function of predator biomass, consumption for the whole North Sea population could then be estimated using Sparholt's (1990) estimates of North Sea horse mackerel biomass (see Table 1).

Horse mackerel diet by length class in the Danish study area is given in Table 28. The number of horse mackerel at length estimated to be in the area, and the total quantity of food consumed each day in quarter three by horse mackerel of given length, is shown in Table 29. Numbers at length were converted to weight at length using the length-weight relationship determined by Coull *et al.* (1989). Total daily food consumption as a percentage of horse mackerel biomass at each length class was then calculated. Knowing diet at length, daily consumption of each prey type by each horse mackerel length class could be estimated. Summing consumption rates across length classes provided estimates of the total quarter three daily consumption of each prey by the entire population of horse mackerel in the Danish study area. These consumption rates are also expressed as a percentage of the total population biomass (Table 30). Prey consumption by horse mackerel in the remaining three quarters was estimated by assuming the same diet throughout the year, and by varying daily consumption rates as a proportion of horse mackerel population biomass to the same extent as mackerel seasonal variation in daily consumption (Table 31 and 32). The total daily consumption of each prey by horse mackerel over the whole North Sea in each quarter of the year was then estimated by applying these consumption rates to Sparholt's (1990) North Sea horse mackerel biomass estimates (Table 33).

The daily food consumption rate of horse mackerel, as a proportion of predator biomass, was 3.41 times higher than that estimated for mackerel despite the same digestion model being used for both species. The mean stomach weight of horse mackerel, as a proportion of body weight, was marginally higher in the Danish study than that noted for mackerel by Daan (1989). However, the main reason for the large discrepancy in daily consumption rates lay in the difference between the stomach evacuation rates estimated for the two predators. The evacuation rate estimated for horse mackerel (Dahl and Kirkegaard, 1987) was 2.6 times faster than the rate calculated for mackerel (Mehl and Westgard, 1983a; 1983b).

Diet and Daily Food Consumption of Pelagic Planktivores

Four species, Norway pout, herring, sprat and sandeel, made up between 97% and 100% of the biomass of the Pelagic planktivore predator guild (Table 1). Albert (1991) described the diet of Norway pout in summer and winter in the Norwegian Deeps region of the North Sea. Data for two length groups, corresponding approximately to "1" group and "2+" group fish, were given. The diet in this study was similar to that described by Raitt and Adams (1965) whose study covered a much wider area of the North Sea. The winter diet was used for quarters 1 and 4 while the summer diet was used for quarters 2 and 3. In autumn there appears little difference between the diets of "0" and "1" group Norway pout (Robb, 1981; Robb and Hislop, 1980), so Albert's (1991) "1" group diet was used as an approximation of the diet of "0" group fish in quarters 3 and 4.

Albert's (1991) diet data were presented as percentage of dry weight (Table 34). For compatibility with the rest of the fish species examined here, these data were converted to percentage of wet weight. Multiplying the number of full stomachs by the mean stomach contents dry weight determined the total dry weight of material examined in each age/time-period sample (Table 35). Multiplying these by the proportion dry weight contribution to the diet of each prey item produced estimates of the total dry weight of each prey item in each age/time-period sample (Table 36). Further multiplying these values by appropriate dry-weight:wet-weight ratios (Bamstedt, 1981; Omori, 1969; Raymont *et al.*, 1971; Rumohr *et al.*, 1987) (see Table 37) converted prey dry weights to wet weight values (Table 38). Summing over all prey items provided an estimate of the total wet weight of prey material examined in each age/time-period sample. The mean stomach contents wet weight could then be determined. In calculating the latter, the total wet weight of material examined in each age/time-period sample was divided by the total number of stomachs examined, ie the number of "full" and "empty" stomachs summed. The percentage wet weight contribution of each prey item to the diet of Norway pout, by age and quarter, is given in Table 39.

The mean weight and length of fish, and the biomass of Norway pout, belonging to each age group in each quarter was determined from the MSVPA output in the same way as for the gadoid species (Table 40, Fig. 2). Jones' (1974) digestion model was applied to the mean stomach content wet weight values in each age/time-period sample to estimate daily food consumption (Table 41). The consumption coefficients of "0" group fish were assumed to be 20% higher than "1" group coefficients in quarters 2, 3, and 4 (eg Daan, 1973). The total quantity of each prey type consumed daily by Norway pout, by age and quarter, is shown in Table 42.

Last (1989) provided herring diet-at-length data for February, May and August/September collected between 1983 and 1986. The diet described in this study was similar to herring diets described previously (Hardy, 1924; Savage, 1937). For the purposes of this document, the May data were excluded since they were collected from the extreme eastern region of the North Sea, and differed markedly from the diets reported for the other two times of the year when the data were collected from a more widespread area.

The data were presented as the numbers of each prey item recovered from all stomachs taken from herring of a given length class (Table 43). However, data on the percentage weight contribution to the total diet (all length groups combined) of major prey were also given for each sampling period. Dividing the percentage contribution by weight of a prey item by its percentage contribution by number provided "relative weight values" of one item of each prey species (Table 43). Corresponding "relative single item weight values" of minor prey were then estimated following reference to unpublished information regarding the size of planktonic organisms (S.J. Hay, Personal Communication). The diet-at-length data could then be converted from numbers of each prey to relative weight of each prey by multiplying the number of a prey item recovered by its "relative single item weight value" (Table 44), so allowing the diet, as a percentage by weight, to be determined (Table 45). A standard age/length key (Table 46; Marine Laboratory, unpublished data) was then used to convert the diet by length class to diet at age. The February diet was used for quarters one and four (a straight arithmetic mean of the three years data derived from Last's (1989) study was used for this purpose) and the August/September diet was used for quarters two and three (Table 47).

There is a shortage of information concerning herring daily food consumption rates. Some published work suggests that the gastric emptying time of herring is of the order of 6 h to 12 h (Daan *et al.*, 1985; Temming and Koster, 1990). Shipboard tank experiments suggested that herring of mean length 20 cm and 24 cm had average stomach weight contents of 0.3 g and 0.5 g respectively. In both cases the gastric emptying time was approximately 12 h (Koster *et al.*, 1990).

Applying Daan's (1973) digestion model to these data indicated consumption rates of 1.2 $g.day^{-1}$ and 2.0 $g.day^{-1}$. In fish weighing 70 g and 123 g respectively (Coull *et al.*, 1989), these daily rations represent consumption coefficients of 1.7% and 1.6% of body weight per day. These two lengths correspond approximately to one and two year old herring; "0" group herring were arbitrarily assigned a daily consumption coefficient of 2.0%$BW.day^{-1}$ while "3", "4", "5", and "6+" group herring were assigned coefficients of 1.5%$BW.day^{-1}$, 1.45%$BW.day^{-1}$, 1.4%$BW.day^{-1}$ and 1.35%$BW.day^{-1}$ respectively. The tank experiments were carried out in autumn, so these consumption rates were used for quarters 2 and 3. Herring feeding activity is generally lower over the winter period (October to March), although this decline is less pronounced among the young fish of the year (Daan *et al.*, 1985; Last, 1989). Thus, in quarter 4, the daily consumption coefficients of "1" group and older herring were reduced to 67% of their quarter 2 and 3 values, while the "0" group coefficient was reduced to 75%. In quarter 1, consumption coefficients of "2" group and older herring were reduced to 50% of their quarter 2 and 3 values, while the "1" group rate was reduced to 60%. Table 48 summarizes herring daily food consumption rates, by age and quarter.

The biomass of herring belonging to each age group in each quarter was determined from the MSVPA output in the same way as for the gadoid fish (Table 49, Fig. 2). The total quantity of food consumed daily by different age groups of herring in each quarter could then be calculated, as could the total biomass of each prey type (Table 50).

In the absence of sprat daily food consumption rate data, sprats were considered to have the same daily consumption rate (as a percentage of the total population biomass) as that part of the herring population up to 15 cm in length. Thus sprat daily consumption rates were 1.02% $Biomass.day^{-1}$ in quarter 1, 1.70% $Biomass.day^{-1}$ in quarter 2, 1.76% $Biomass.day^{-1}$ in quarter 3 and 1.30% $Biomass.day^{-1}$ in quarter 4. Daily consumption rate data were not available for sandeels either, so these population daily consumption rates were applied to sandeels as well. Knowing the biomass of sprats and sandeels in each quarter of the year (see Table 1), the total daily food consumption by these two species could then be determined, by age and quarter (Table 51).

The principal prey of sprats of 2-15 cm length were copepods; non-copepod prey included ostracods and juvenile mysids. The only seasonal variation in the diet consisted of the substitution of one copepod species for another (Last, 1982). Similarly the diet of sandeels of all lengths consists almost exclusively of copepods throughout the year (Macer, 1966; Wilson and Bailey, 1991). The diets of sprats and sandeels were therefore considered to consist entirely of the prey guild Meso-zooplankton Omnivores (see next section) in all four quarters of the year.

Calculation of Static Daily Predation Loadings

Each prey item mentioned in the fish diet studies quoted was assigned to a life history-feeding type prey guild. The assignment of prey to their various prey guilds is listed in Appendix II. The total daily consumption of each prey guild by each fish predator in each quarter was calculated. The area of the North Sea was assumed to be 570,000 km^2 (Jones 1982), enabling these daily consumption rates to be expressed as milligrams per square metre per day ($mg.m^{-2}.d^{-1}$). Derivation of the carbon content (as a proportion of wet weight) of each of the prey guilds is given in Table 52, enabling daily consumption rates to be further expressed as micro-grams of carbon per square metre per day ($\mu gC.m^{-2}.d^{-1}$). These daily consumption rate data are given for the thirteen predators considered above in Tables 53 to 65.

Table 52 gives an approximate value for carbon as a proportion of organism wet weight. The macro-benthos deposit, macro-benthos carnivore, and the mega-benthos guilds, are based on crustacea values, since this taxon makes up the bulk of the prey taken by fish feeding on these groups. The macro-benthos filter-feeder guild is assumed to consist of

bivalves. In both cases carbon is assumed to make up 50% of the organic mass. Hay *et al.* (1990) assume that the carbon content of jelly fish is approximately 0.2%. However few fish eat jelly fish, so the meso-zooplankton carnivore prey of fish are assumed to consist of crustacea.

The daily consumption of each prey guild was summed over the fish species within each of the four predator guilds. Total daily consumption by each whole predator guild was then determined by raising these summed values by the ratio:

(KDB+UDB)/KDB

where KDB stands for "known diet biomass", ie the combined biomass of the species for which diet and consumption data were available, and UDB stands for "unknown diet biomass", ie the biomass of the remaining species in a particular fish guild for which quarterly diet and consumption data could not be directly estimated. These data are presented in Tables 66 to 69. Finally, Table 70 combines these tables to give estimates of the total consumption of each prey guild by the whole fish assemblage in each quarter of the year: annual consumption values are given in Table 71.

Discussion

The total annual consumption of fish by fish estimated in this document is approximately equal to the biomass of the average standing crop of North Sea fish (*ca* 10.8 million tonnes (Yang, 1982: Sparholt, 1990, Daan *et al.*, 1990)), and approximately 2.5 times higher than previous estimates (eg Bax, 1991). How can this be so?

The choice of digestion model can have a large effect on the resulting daily ration estimates. The use of Jones' (1974) model resulted in whiting daily ration estimates nearly twice those estimated when using Daan's (1973) model (Hislop *et al.*, 1991). Fish food consumption rates in MSVPA studies, on which Bax's (1991) estimates are based, are derived from Daan's (1973) digestion model. Thus, the use here of Jones' (1974) digestion model for gadoids may account, at least in part, for the higher annual fish consumption by fish calculated in this study. But which estimate is right? Jones' (1974) digestion model produced whiting daily ration estimates sufficient to provide, and similar in size to, their estimated daily energy requirement (Jones and Hislop, 1978; Hislop *et al.*, 1991), thus favouring the use of Jones' model. However, in a previous study, application of Daan's (1973) model produced cod food consumption rates that were adequate to meet their estimated daily energy requirements (Daan, 1975). The fact that these digestion models provide such divergent results when applied to the same set of data highlights the importance of using suitable models, the validation of which is clearly a topic requiring further and immediate work.

One possible disadvantage of the digestion models used in this study is that they assume that the rate of digestion is independent of prey size, and hence, because larger predators take larger prey (Daan, 1973; 1989; Hislop *et al.*, 1991), also independent of predator size. A consequence of this is that daily consumption coefficients tend to decrease little with increasing predator size (eg Daan, 1973). However, the existence of an inverse relationship between prey size and digestion rate as a hard and fast rule is also not uncontested (eg Macpherson *et al.*, 1989). The suitability of the various digestion models that have been proposed over the years (eg Elliott and Persson, 1978; Jobling, 1981; Pennington, 1985; and references already cited) has been the subject of much debate (eg Andersen, 1985). Resolving this argument is not the purpose of this document. In addition to the reason given above, Jones' (1974) digestion model was used in this study because of its explicit dependence on water temperature; thus providing a degree of seasonality in the estimates of daily food consumption. Daan (1973) observed no significant seasonal variation in cod stomach weight and his model does not allow for any temperature dependent seasonality in digestion rate to be accounted for.

The total estimate of approximately 55.5 million tonnes of food consumed by fish in the North Sea each year actually works out at an average daily consumption rate of 1.4% of predator biomass per day, which is in good agreement with many published fish daily food consumption rates (Daan, 1973; Armstrong, 1982; Basimi and Grove, 1985; Hislop *et al.*, 1991). That fish make up 18.4% of this food does not seem unreasonable when one considers that fish classed here as either Demersal Piscivores or Pelagic Piscivores make up between 25% and 37% of the total fish biomass over the year. The question remains then, as to whether the ecosystem in the North Sea can provide such quantities of food for fish. Problems of food supply to fish have emerged in other studies; for example, according to Cramer and Daan (1986), cod and haddock alone consume almost all the benthos production each year, virtually nothing being left for other benthivorous fish!

A detailed energy budget analysis for the North Sea, relating the actual daily consumption of food by fish to estimates of the daily production of their various prey, is in progress. Previous foodweb energy budget studies only managed to balance the budget by constraining fish to feeding at unrealistically low trophic levels (Steele, 1974; Jones, 1982; 1984). This suggests that the food supply problem is insoluble. However these studies implicitly assumed that the North Sea was a closed system, and this is certainly not the case. Large quantities of zooplankton enter the North Sea through the Fair Isle Channel and considerable migration of fish into and out of the North Sea also occurs. Static models are not best suited to modelling open systems. Perhaps dynamic models, such as ERSEM, can provide the answer to this dilemma.

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Table 1

Biomass (tonnes) of fish belonging to each "feeding type" (after Sparholt, 1990)

		1 January	1 April	1 July	1 October
Demersal piscivores	Cod	261000	244666	228333	212000
	Haddock	473000	526333	579666	633000
	Saithe	477000	490000	503000	516000
	Whiting	355000	397333	439666	482000
Commercial biomass		1566000	1658332	1750665	1843000
Non-commercial biomass		395013	485162	576093	667878
Total D piscivore biomass		1961013	2143494	2326758	2510878
% biomass non-commercial		20.14	22.63	24.76	26.60
% "known diet biomass"		79.86	77.37	75.24	73.40
Demersal benthivores	Plaice	475000	475000	475000	475000
	Sole	60000	60000	60000	60000
	Common dab	1576000	1590667	1605333	1620000
	Lemon sole	226000	204667	183333	162000
Commercial biomass		761000	739667	718333	697000
Non-commercial biomass		2081000	2189602	2143111	1941524
Total D benthivore biomass		2842000	2929269	2861444	2638524
% biomass non-commercial		73.22	74.75	74.90	73.58
% "known diet biomass"		80.12	77.51	79.11	85.54
Pelagic piscivores	Mackerel	156000	344000	532000	720000
	Horse mackerel	5996	392130	918377	1584667
Commercial biomass		156000	344000	532000	720000
Non-commercial biomass		5996	392130	918377	1584667
Total P piscivore biomass		161996	736130	1450377	2304667
% biomass non-commercial		3.70	53.27	63.32	68.76
% "known diet biomass"		100.00	100.00	100.00	100.00
Pelagic planktivores	Norway Pout	948000	1114000	1280000	1446000
	Herring	993000	1215333	1437667	1660000
	Sprat	144000	180000	216000	252000
	Sandeel	1556000	1731000	1906000	2081000
Commercial biomass		3641000	4240333	4839667	5439000
Non-commercial biomass		4992	45107	99420	167931
Total P planktivore biomass		3645992	4285440	4939087	5606931
% biomass non-commercial		0.14	1.05	2.01	3.00
% "known diet biomass"		99.86	98.95	97.99	97.00
Total fish assemblage					
Commercial biomass		6124000	6982332	7840665	8699000
Non-commercial biomass		2487000	3112001	3737001	4362000
Total biomass		8611000	10094333	11577666	13061000
% biomass non-commercial		28.88	30.83	32.28	33.40
% "known diet biomass"		89.49	88.81	89.52	91.14

Table 2

Diet (% by weight) of cod by age and quarter (Daan, 1973; 1989; Vea Salvanes, 1986)

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 1							Quarter 2						
Phaeophyta	.00	.00	.02	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Porifora	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cnidaria	.00	.12	.12	.10	.09	.08	.03	.00	.09	.18	.06	.10	.10	.03
Annellida	.00	8.90	8.78	5.02	2.74	2.26	1.40	.00	9.02	5.74	4.29	3.80	3.95	5.83
Gastropoda	.00	3.31	1.76	.49	.35	.32	.29	.00	1.34	1.01	.15	.05	.05	.01
Bivalvia	.00	6.84	5.46	1.03	.25	.18	.15	.00	2.35	.74	.12	.01	.00	.00
Scaphopoda	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cephalopoda	.00	2.21	1.92	.83	.55	.48	.33	.00	.22	.05	.07	.14	.15	.14
Pycnogonida	.00	.46	.08	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Mysidia	.00	.70	.11	.01	.00	.00	.00	.00	.32	.02	.00	.00	.00	.00
Cumacea	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00
Valvifera	.00	.14	.06	.08	.02	.01	.00	.00	.44	.06	.01	.00	.00	.00
Gammaridea	.00	1.02	.10	.01	.00	.00	.00	.00	.11	.01	.00	.00	.00	.00
Hyperiidea	.00	.21	.39	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Euphausiacea	.00	2.00	1.20	.09	.01	.00	.00	.00	11.18	7.34	6.91	10.77	10.65	3.12
Crangonidae	.00	18.23	2.01	.55	.25	.20	.08	.00	4.33	.74	.05	.00	.00	.02
Other Caridea	.00	11.29	4.04	1.00	.36	.24	.13	.00	3.14	1.71	.44	.10	.06	.16
Nephrops	.00	.76	.66	1.80	3.49	3.76	2.16	.00	.06	1.74	6.63	10.09	11.30	18.78
Anomura	.00	12.03	9.51	3.15	1.25	.96	.95	.00	10.32	5.91	1.92	.47	.29	.09
Oxystomata	.00	.00	.04	.01	.00	.00	.00	.00	.04	.02	.00	.00	.00	.00
Oxyrhyncha	.00	.33	1.74	.66	.15	.08	.03	.00	.60	1.25	.97	.24	.11	.03
Cancridea	.00	.07	1.15	1.07	.96	.96	.93	.00	1.79	8.00	13.07	12.27	11.67	7.51
Brachyrhyncha	.00	2.75	11.55	8.23	3.57	2.86	2.25	.00	6.34	8.19	5.98	4.66	4.32	2.35
Sipuncula	.00	.08	.00	.00	.00	.00	.00	.00	.03	.00	.00	.00	.00	.00
Echiura	.00	.09	.96	.54	.11	.04	.01	.00	.34	.02	.00	.00	.00	.00
Priapulida	.00	.04	.05	.01	.00	.00	.00	.00	.06	.05	.01	.00	.00	.00
Echinodermata	.00	.13	.76	.95	.38	.26	.12	.00	1.58	4.47	2.17	.26	.01	.00
Chaetognatha	.00	.01	.04	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00
Urochordata	.00	.00	.01	.00	.00	.00	.00	.00	.07	.05	.00	.00	.00	.00
Cephalochordata	.00	.00	.06	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cod	.00	.00	1.04	3.08	9.55	10.92	9.50	.00	.99	1.36	4.04	7.72	7.74	2.19
Haddock	.00	.80	3.80	8.71	18.55	20.05	8.10	.00	1.76	3.12	5.48	5.73	5.39	1.91
Whiting	.00	.08	7.30	21.49	28.61	29.68	29.88	.00	.08	2.38	6.34	8.62	9.62	16.54
Norway pout	.00	3.61	3.82	4.62	3.56	3.16	1.42	.00	1.26	2.67	4.23	4.36	4.10	1.50
Herring	.00	.14	2.91	5.44	3.07	2.45	2.65	.00	.20	1.20	2.48	4.03	4.07	1.99
Sprat	.00	8.81	8.40	4.83	3.07	2.76	2.69	.00	1.35	3.43	1.98	.88	.86	2.29
Sandeels	.00	1.11	8.91	12.53	2.92	.69	.15	.00	32.77	25.10	11.55	6.84	5.89	2.77
Plaice	.00	.00	.01	.16	.94	1.25	3.75	.00	.00	.06	.14	.08	.20	1.57
Sole	.00	.00	.12	.06	.39	.46	.16	.00	.00	.08	.04	.00	.00	.00
Lemon sole	.00	.00	.00	.03	.31	.54	3.67	.00	.00	.00	.00	.00	.00	.00
Dab	.00	.38	3.26	7.32	7.87	8.33	16.57	.00	.56	4.50	10.02	7.72	7.36	8.59
Mackerel	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Long rough dab	.00	3.33	1.96	1.52	1.66	1.75	3.15	.00	1.81	2.20	2.71	2.77	3.03	5.65
Dragonets	.00	3.33	1.96	1.52	1.66	1.75	3.15	.00	1.80	2.19	2.71	2.76	3.02	5.65
Unidentified gobies	.00	6.67	3.94	3.03	3.29	3.49	6.29	.00	3.63	4.41	5.43	5.54	6.06	11.29
Unidentified prey	.00	.02	.00	.00	.03	.03	.01	.00	.00	.00	.00	.00	.00	.00

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 3							Quarter 4						
Phaeophyta	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Porifora	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cnidaria	.03	.00	.01	.01	.01	.00	.00	.00	.07	.07	.06	.04	.04	.01
Annellida	1.02	5.50	5.56	6.85	9.03	8.69	1.33	4.08	7.20	7.93	4.43	1.73	1.41	1.39
Gastropoda	.00	1.63	.72	.17	.03	.02	.00	.67	1.26	.75	.58	.60	.61	.12
Bivalvia	5.80	.05	.75	.53	.09	.02	.00	.27	1.62	.71	.16	.02	.02	.01
Scaphopoda	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cephalopoda	.00	.02	.26	.14	.13	.14	.14	.58	.53	.51	4.90	8.06	8.39	6.03
Pycnogonida	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Mysidia	.76	.02	.00	.00	.00	.00	.00	.41	.01	.00	.00	.00	.00	.00
Cumacea	.16	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Valvifera	.00	.29	.01	.00	.00	.00	.00	.00	.00	.00	.01	.01	.01	.00
Gammaridea	3.27	.00	.00	.00	.00	.00	.00	.05	.19	.06	.00	.00	.00	.00
Hyperiidea	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Euphausiacea	.00	9.65	7.91	5.57	1.09	.15	.01	.04	.04	.02	.00	.00	.00	.00
Crangonidae	41.45	.83	.36	.23	.29	.29	.03	39.35	11.83	6.25	1.81	.12	.05	.02
Other Caridea	5.16	.93	.59	.26	.04	.02	.00	7.74	1.81	1.17	.52	.22	.20	.08
Nephrops	.00	1.02	5.22	10.25	12.50	12.14	7.14	.00	2.91	3.38	2.87	2.32	2.31	.44
Anomura	2.15	8.43	3.65	1.62	.48	.30	.03	9.94	9.14	5.67	2.51	1.27	1.15	.90
Oxystomata	.00	.16	.03	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Oxyrhyncha	.00	.73	1.49	1.21	.33	.15	.02	.10	.81	.50	.21	.09	.09	.02
Cancridea	.35	3.45	3.39	2.85	1.31	.90	.10	.22	1.65	1.84	1.56	1.31	1.29	1.40
Brachyrhyncha	13.48	16.01	10.81	6.70	4.39	4.25	5.33	12.06	21.21	28.05	17.05	7.25	6.03	3.69
Sipuncula	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Echiura	.00	.00	.00	.00	.00	.00	.00	.23	.44	.21	.05	.00	.00	.00
Priapulida	.01	.03	.01	.00	.00	.00	.00	.05	3.47	1.56	.33	.00	.00	.00
Echinodermata	.06	.26	.84	.83	.55	.46	.07	.02	.07	.07	.03	.01	.00	.00
Chaetognatha	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Urochordata	.00	.00	.00	.00	.00	.00	.00	.20	.02	.01	.00	.00	.00	.00
Cephalochordata	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cod	.00	8.06	2.63	1.06	1.51	1.44	.16	.10	.05	.30	5.62	9.37	9.77	3.02
Haddock	.00	5.50	8.57	10.20	11.76	13.80	30.83	1.17	9.88	8.43	12.39	15.56	16.03	27.74
Whiting	.91	12.28	5.50	3.05	2.99	2.94	1.73	.00	.80	1.60	10.24	16.22	16.86	15.00
Norway pout	.00	2.99	17.70	23.00	20.65	18.33	2.98	1.01	6.56	8.29	7.51	6.56	6.36	2.83
Herring	.00	4.32	5.88	8.51	13.51	13.25	1.48	.00	2.16	1.95	1.76	1.62	1.68	.32
Sprat	.00	2.17	2.83	.87	.03	.00	.00	.08	.40	.90	.91	.77	.75	.14
Sandeels	.78	8.07	6.69	3.12	.76	.47	.05	3.38	4.94	2.60	4.16	5.94	6.17	7.70
Plaice	.00	.08	.02	.00	.00	1.20	12.75	.00	.00	.05	.03	.00	.00	.19
Sole	.00	.08	.02	.07	.16	.19	.23	.00	.14	.24	.15	.06	.04	.99
Lemon sole	.00	.00	.08	.10	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00
Dab	2.51	1.30	2.35	4.19	5.82	5.58	.81	1.36	1.83	2.15	6.85	10.13	10.47	23.97
Mackerel	.00	.00	.01	.88	2.12	2.52	4.33	.00	.08	6.32	4.89	2.19	1.70	.32
Long rough dab	5.52	1.53	1.53	1.93	2.60	3.19	7.61	4.22	2.20	2.10	2.10	2.13	2.14	.92
Dragonets	5.52	1.53	1.53	1.93	2.59	3.19	7.61	4.22	2.20	2.10	2.10	2.13	2.14	.91
Unidentified gobies	11.06	3.05	3.05	3.85	5.21	6.38	15.22	8.44	4.48	4.20	4.20	4.27	4.28	1.84
Unidentified prey	.00	.04	.01	.02	.00	.00	.01	.01	.00	.01	.01	.00	.01	.00

Table 3

Diet (% by weight) of haddock by age and quarter (Cranmer, 1986; Daan 1989)

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 1							Quarter 2						
Cnidaria	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Ctenophora	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Rhynchocoela	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Annellida	.00	25.99	19.07	11.71	9.15	11.54	12.01	14.99	17.15	7.25	5.20	4.41	3.94	3.86
Gastropoda	.00	1.66	1.63	.92	1.20	1.66	1.72	.00	.00	.11	.29	.30	.90	.98
Polyplacophora	.00	.00	.00	.00	.01	.01	.01	.00	.00	.00	.00	.00	.00	.00
Bivalvia	.00	2.64	7.26	5.28	2.88	1.40	1.28	3.10	5.25	3.98	2.61	2.22	1.77	1.73
Scaphopoda	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.02	.01	.00	.00
Cephalopoda	.00	7.92	1.88	1.16	1.31	.71	.59	.00	.02	.83	.63	.14	.00	.00
Pycnogonida	.00	.01	.02	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00
Calanoida	.00	.00	.00	.00	.00	.00	.00	.05	1.32	1.55	1.33	1.03	.77	.76
Leptostraca	.00	.01	.03	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Mysidia	.00	.04	.04	.02	.01	.00	.00	.23	.06	.00	.00	.00	.00	.00
Cumacea	.00	.06	.05	.04	.02	.01	.00	.00	.07	.01	.00	.00	.00	.00
Tanaidacea	.00	.25	.07	.07	.10	.05	.04	.00	.00	.00	.00	.00	.00	.00
Flabellifera	.00	2.96	3.04	2.12	2.12	1.61	1.53	.09	.17	.62	.33	.19	.12	.20
Valvifera	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Asellota	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Gammaridea	.00	4.31	2.36	1.50	.80	.33	.29	1.14	3.83	1.09	.37	.17	.09	.09
Hyperiidea	.00	.21	.40	.18	.06	.03	.03	.12	.35	.11	.16	.04	.00	.00
Caprellidea	.00	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Euphausiacea	.00	4.21	2.56	2.46	5.18	7.44	7.62	8.00	11.37	13.17	9.18	6.29	4.71	4.61
Crangonidae	.00	.51	.33	.13	.07	.01	.01	.00	.00	.00	.00	.00	.00	.00
Caridea	.00	3.65	2.95	1.63	1.00	.36	.29	4.25	2.95	1.90	.41	.13	.22	.21
Anomura	.00	4.02	3.43	3.42	6.43	7.07	6.99	5.87	2.30	.77	1.49	1.32	1.02	1.00
Oxyrhyncha	.00	.02	.18	.13	.15	.23	.24	1.31	.89	.71	.18	.03	.01	.01
Cancridea	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05	.09	.02	.00	.00
Brachyrhyncha	.00	.08	.57	.35	.47	.82	.86	.00	.01	.14	.12	.03	.00	.16
Echiura	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Echinodermata	.00	22.35	15.87	15.77	12.44	7.78	7.31	30.34	29.09	12.53	9.64	11.43	11.55	11.86
Chaetognatha	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Urochordata	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cephalochordata	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cod	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Haddock	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Whiting	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Norway pout	.00	.00	16.65	24.32	33.24	35.08	34.78	.00	.00	.02	.82	4.60	7.03	6.89
Herring	.00	.00	.00	.05	1.37	5.68	6.28	.00	.00	.00	.00	.00	.00	.00
Sprat	.00	.10	1.52	5.21	3.35	1.91	1.86	.00	.00	.00	.05	.29	.31	.30
Sandeels	.00	.13	.92	4.38	7.25	6.77	6.56	.00	.00	.00	.00	.00	.00	.00
Dab	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Long rough dab	.00	3.43	4.40	4.50	2.23	1.71	1.77	1.43	2.80	13.92	20.59	21.02	21.41	21.20
Pearl-sides	.00	3.43	4.40	4.50	2.23	1.71	1.77	1.43	2.80	13.92	20.59	21.02	21.41	21.20
Unidentified gobies	.00	3.43	4.40	4.50	2.23	1.71	1.77	1.43	2.80	13.92	20.59	21.02	21.41	21.20
Unidentified prey	.00	8.53	5.96	5.62	4.70	4.36	4.38	26.22	16.77	13.39	5.30	4.30	3.32	3.74

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 3							Quarter 4						
Cnidaria	.00	.00	.00	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00
Ctenophora	.00	.00	.00	.00	.01	.03	.02	.00	.00	.00	.00	.00	.00	.00
Rhynchocoela	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Annellida	10.21	8.94	6.13	4.78	3.32	2.14	2.35	10.54	11.30	10.89	13.16	11.38	8.04	10.80
Gastropoda	.02	.37	.20	.38	.37	.16	.29	.65	.39	.35	.86	.71	.27	.68
Polyplacophora	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Bivalvia	.19	3.13	3.63	2.61	1.79	1.25	1.29	2.50	3.90	2.99	2.13	1.23	.85	.84
Scaphopoda	.00	.00	.08	.08	.03	.01	.01	.00	.01	.01	.00	.00	.00	.00
Cephalopoda	.00	.11	.18	.05	.01	.00	.00	.40	1.04	1.12	2.07	1.68	.70	1.57
Pycnogonida	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Calanoida	.05	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Leptostraca	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Mysidia	.42	.11	.03	.00	.00	.00	.00	.00	.00	.00	.01	.01	.00	.01
Cumacea	.39	.01	.00	.00	.00	.00	.00	.73	.13	.27	.29	.19	.09	.14
Tanaidacea	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Flabellifera	.09	.53	.43	.19	.08	.02	.03	.58	.68	.65	.33	.27	.37	.24
Valvifera	.00	.04	.04	.03	.02	.01	.02	.40	.54	.15	.07	.05	.04	.05
Asellota	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Gammaridea	1.23	.48	.48	.25	.10	.03	.04	1.17	.57	.19	.11	.09	.08	.09
Hyperiidea	.12	.04	.14	.28	.26	.11	.19	1.58	7.36	9.53	5.59	5.38	6.26	5.25
Caprellidea	.02	.01	.00	.00	.00	.00	.00	.11	.00	.00	.00	.00	.00	.00
Euphausiacea	25.24	15.73	20.15	14.94	8.66	4.09	5.10	3.10	.05	.07	.10	.48	.91	.63
Crangonidae	.46	.24	.04	.03	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00
Caridea	1.47	.67	.48	.33	.14	.05	.05	5.45	3.52	3.11	1.53	.67	.44	.30
Anomura	.14	2.12	1.06	.52	1.25	2.77	2.65	1.32	2.85	2.73	2.10	4.23	7.12	5.00
Oxyrhyncha	.15	2.00	1.63	.53	.28	.19	.18	1.37	.65	.08	.03	.01	.01	.01
Cancridea	.01	.06	.11	.09	.06	.06	.64	.00	.00	.01	.01	.01	.02	.01
Brachyrhyncha	.49	.22	.26	.40	.46	.32	.40	2.10	2.93	2.46	1.30	.98	1.11	.83
Echiura	.00	.00	.00	.00	.00	.00	.00	.01	.02	.01	.02	.02	.01	.02
Echinodermata	1.90	9.51	11.38	9.84	6.99	4.68	12.27	12.37	9.61	7.02	6.16	7.07	8.33	7.40
Chaetognatha	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Urochordata	1.01	2.52	1.24	.46	.15	.03	.03	.00	.00	.02	.13	.11	.04	.11
Cephalochordata	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cod	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Haddock	.00	.06	.20	.43	.43	.19	.33	.00	.08	.06	.00	.00	.00	.00
Whiting	.00	.00	.00	.01	.09	.23	.14	.00	.01	.07	.29	.25	.09	.24
Norway pout	.16	1.39	5.94	12.47	20.26	28.24	22.48	1.39	5.25	6.83	7.54	10.01	12.59	10.95
Herring	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.30	.27	.09	.27
Sprat	.00	.01	.17	.18	.19	.35	.22	.00	.00	.00	.00	.00	.00	.00
Sandeels	9.14	11.82	12.27	7.78	5.00	2.47	3.24	1.28	4.69	21.46	23.16	20.42	18.62	19.26
Dab	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00
Long rough dab	10.19	11.15	9.17	12.92	15.66	16.87	15.31	13.27	12.44	8.54	9.97	10.62	10.41	10.93
Pearl-sides	10.19	11.15	9.17	12.92	15.66	16.87	15.31	13.27	12.44	8.54	9.97	10.62	10.41	10.93
Unidentified gobies	10.19	11.15	9.17	12.92	15.66	16.87	15.31	13.27	12.44	8.54	9.97	10.62	10.41	10.93
Unidentified prey	16.53	6.41	6.22	4.56	3.05	1.97	2.10	13.14	7.09	4.29	2.79	2.62	2.70	2.51

Table 4

Diet (% by weight) of whiting by age and quarter (Daan, 1989; Hislop *et al.*, 1983, 1991; Robb, 1981; Robb and Hislop, 1980)

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 1							Quarter 2						
Porifera	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05	.01	.00	.00	.00
Cnidaria	.00	.00	.00	.00	.00	.00	.00	.00	.38	.27	.03	.58	2.59	.32
Ctenophora	.00	.01	.05	.07	.01	.01	.00	.00	.00	.00	.00	.00	.01	.00
Nemertea	.00	.00	.00	.01	.02	.01	.01	.00	.00	.00	.00	.03	.13	.26
Platyhelminthes	.00	.00	.00	.03	.05	.05	.01	.00	.00	.00	.00	.00	.00	.00
Annellida	.00	5.05	2.52	.89	.38	.41	.25	.00	1.57	2.01	.80	2.87	3.49	1.50
Gastropoda	.00	.01	.02	.16	.25	.21	.16	.00	.03	.07	.13	.16	.05	.06
Bivalvia	.00	.05	.16	.09	.01	.01	.00	.00	.01	.05	.01	.04	.01	.01
Cephalopoda	.00	14.04	9.71	4.54	1.59	1.02	.52	.00	3.17	.52	.15	.38	.22	.16
Unidentified molluscs	.00	1.54	1.07	.34	.45	.47	.15	.00	.02	.00	.02	.08	.10	.06
Copepoda	.00	.14	.00	.00	.00	.00	.00	.00	.25	.09	.08	.03	.00	.08
Mysidia	.00	.08	.02	.01	.01	.01	.01	.00	.06	.01	.01	.02	.01	.01
Cumacea	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Isopoda	.00	.15	.14	.27	.27	.23	.21	.00	.12	.14	.05	.05	.02	.04
Amphipoda	.00	.31	.23	.08	.05	.05	.04	.00	1.32	.08	.04	.03	.01	.01
Euphausiacea	.00	13.79	20.49	19.35	14.51	10.84	8.65	.00	33.83	18.34	11.88	6.99	4.65	4.52
Crangonidae	.00	.23	.33	.21	.21	.20	.08	.00	.00	.00	.00	.00	.00	.00
Pandalidae	.00	.23	.22	.43	.41	.31	.25	.00	.00	.12	.72	1.08	.47	1.69
Caridea	.00	12.80	4.08	2.52	1.80	1.44	1.11	.00	1.43	1.06	2.15	2.85	2.69	2.44
Macrura	.00	3.21	.81	.26	.23	.23	.07	.00	.08	.03	.05	.14	.05	.06
Anomura	.00	.30	.22	.07	.09	.13	.05	.00	.04	.38	.12	.30	.04	.06
Brachyura	.00	.12	.01	.06	.66	3.78	1.80	.00	.08	.03	.53	2.81	4.22	1.69
Unidentified crustacea	.00	2.92	2.57	.99	.00	.00	.00	.00	1.15	.78	.10	1.32	1.56	.00
Echiura	.00	.20	.03	.05	.07	.07	.02	.00	.02	.00	.00	.00	.00	.00
Priapulida	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Echinodermata	.00	.00	.00	.00	.00	.00	.00	.00	.01	.06	.05	.03	.00	.00
Chaetognatha	.00	.17	.01	.00	.00	.00	.00	.00	.68	.39	.32	.15	.03	.14
Appendicularia	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Urochordata	.00	.21	.20	.04	.00	.00	.00	.00	2.44	.76	.15	.43	.03	.03
Cod	.00	.00	.22	.05	.00	.00	3.35	.00	.56	.30	.59	.19	.04	.23
Haddock	.00	1.14	.22	1.66	2.47	2.64	4.36	.00	.00	.42	3.89	5.19	2.34	8.33
Whiting	.00	.00	.33	2.30	5.74	15.75	7.11	.00	.00	.54	2.84	3.96	3.21	2.85
Norway pout	.00	3.18	5.50	21.01	30.58	29.40	36.56	.00	.42	7.40	17.69	20.37	31.88	16.79
Herring	.00	.00	12.21	12.49	15.84	9.90	15.95	.00	.28	.84	.52	.45	.00	.00
Sprat	.00	15.91	28.60	21.28	14.26	11.78	7.38	.00	2.25	2.27	1.31	6.24	4.67	2.20
Sandeels	.00	20.23	6.27	4.77	3.64	3.96	4.13	.00	48.10	61.97	54.40	38.27	32.25	45.55
Sole	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Lemon sole	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Dab	.00	.00	.02	.09	.13	.17	.04	.00	.00	.00	.03	.11	.04	.05
Mackerel	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.11	.04	.05
Poor cod	.00	.00	.59	.00	.00	3.85	4.30	.00	.00	.10	.00	.00	2.87	6.01
Silvery pout	.00	.00	.00	2.17	.63	.05	.06	.00	.00	.00	.49	.48	.04	.08
Unidentified rockling	.00	.19	.00	.00	.15	.00	.00	.00	.06	.00	.00	.12	.00	.00
Unidentified gadoids	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Hake	.00	.00	.23	.00	.00	.00	.00	.00	.00	.04	.00	.00	.00	.00
Unidentified clupeoid	.00	.53	.00	.00	.00	.02	.02	.00	.17	.00	.00	.00	.01	.03
Witch	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00
Long rough dab	.00	.05	.04	.40	1.85	.92	1.03	.00	.02	.01	.09	1.40	.69	1.44
Unidentified flatfish	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Wolf fish	.00	.00	.00	.09	.04	.00	.00	.00	.00	.00	.02	.03	.00	.00
Pearl-side	.00	.03	.15	.31	.37	.00	.00	.00	.01	.03	.07	.28	.00	.00
Argentines	.00	.00	.00	.00	.46	1.33	1.48	.00	.00	.00	.00	.35	.99	2.08
Dragonet	.00	.08	.15	.56	.39	.74	.83	.00	.03	.03	.13	.30	.55	1.16
Scad	.00	.00	.00	.00	.04	.00	.00	.00	.00	.00	.00	.03	.00	.00
Norway haddock	.00	.00	.00	.00	.09	.00	.00	.00	.00	.00	.00	.07	.00	.00
Lesser weever	.00	.00	.00	.34	.00	.00	.00	.00	.00	.00	.08	.00	.00	.00
Stickleback	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Unidentified gurnards	.00	.00	.00	.00	.50	.00	.00	.00	.00	.00	.00	.38	.00	.00
Unidentified blennies	.00	.00	.00	.16	.00	.00	.00	.00	.00	.00	.04	.00	.00	.00
Unidentified gobies	.00	3.11	1.92	1.68	1.74	.00	.00	.00	1.01	.34	.38	1.32	.00	.01
Unidentified prey	.00	.00	.65	.14	.00	.00	.00	.00	.41	.48	.00	.00	.00	.00

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 3							Quarter 4						
Porifera	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cnidaria	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.01	.01	.00	.00
Ctenophora	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Nemertea	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Plathhelminthes	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Annellida	10.94	9.36	2.78	.55	.65	.93	.63	5.85	2.02	.45	.20	.20	.21	.03
Gastropoda	.00	3.26	.28	.06	.07	.07	.08	.00	.06	.16	.12	.06	.05	.01
Bivalvia	.00	.01	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00
Cephalopoda	.00	.00	.02	.13	.16	.23	.13	4.00	.55	.43	.27	1.06	.31	7.78
Unidentified molluscs	.00	.39	.17	.04	.08	.04	.00	.00	.00	.00	.00	.00	.00	.00
Copepoda	23.70	.00	.00	.00	.00	.00	.00	3.21	.01	.00	.00	.00	.00	.00
Mysidia	.00	.00	.00	.00	.00	.00	.00	.31	.10	.05	.01	.01	.01	.00
Cumacea	.00	.12	.02	.04	.06	.03	.09	.31	.05	.00	.00	.00	.00	.00
Isopoda	.00	.04	.06	.02	.04	.05	.04	.05	.00	.00	.00	.00	.00	.00
Amphipoda	.26	.17	.20	.11	.16	.06	.30	1.23	.84	3.93	4.71	1.56	.76	1.78
Euphausiacea	.52	3.64	4.94	4.36	5.76	2.21	4.11	.62	.02	.35	1.55	3.68	4.58	6.74
Crangonidae	50.26	.22	.16	.05	.00	.00	.00	18.15	2.26	1.10	.32	.64	.56	.00
Pandalidae	.00	.00	.00	.00	.00	.00	.00	.31	.28	.60	.25	.17	.19	.04
Caridea	4.95	1.38	.34	.13	.20	.23	.18	2.51	4.61	1.40	.62	.51	.47	.35
Macrura	.00	1.18	.12	.04	.04	.04	.03	.00	.29	.10	.06	.07	.08	.00
Anomura	.00	1.36	.22	.10	.25	.33	.24	3.08	2.98	1.53	.24	.80	.18	.03
Brachyura	1.30	3.69	1.63	.61	1.53	1.97	1.56	15.75	3.57	.88	.56	.90	3.37	.42
Unidentified crustacea	.00	10.14	2.57	.55	1.03	1.34	1.21	.00	.00	.00	.00	.00	.00	.10
Echiura	.26	.64	.06	.05	.03	.05	.00	.92	6.21	5.41	.15	2.26	.05	.00
Priapulida	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00
Echinodermata	.00	3.09	.15	.00	.00	.00	.00	.00	.06	.00	.00	.00	.00	.00
Chaetognatha	.00	.03	.00	.00	.00	.00	.00	.31	.61	.24	.09	.05	.00	.00
Appendicularia	.00	.00	.00	.00	.00	.00	.00	.93	.00	.00	.00	.00	.00	.00
Urochordata	.00	.75	.16	.04	.00	.00	.00	.00	1.24	.40	.24	.02	.01	.03
Cod	.02	.00	.00	.00	.00	.00	.00	.04	.09	.22	.49	.61	.66	.48
Haddock	.00	1.64	17.32	23.08	17.42	16.39	19.09	.30	3.21	10.80	20.01	19.97	24.25	29.87
Whiting	.14	6.87	6.68	4.90	3.88	4.51	3.89	2.17	3.02	2.91	3.52	2.48	6.79	2.91
Norway pout	.02	5.02	8.35	13.20	8.38	5.62	5.47	5.52	9.52	21.99	41.22	37.18	20.86	21.80
Herring	.00	1.75	29.24	29.33	20.78	16.39	13.89	.30	6.03	6.03	2.22	8.15	11.41	15.84
Sprat	.00	3.05	7.74	9.72	30.37	44.66	31.19	2.19	21.03	15.79	6.79	7.18	5.36	1.05
Sandeels	3.66	39.61	16.14	12.09	7.83	3.32	9.02	18.91	24.99	22.48	15.02	9.04	8.24	5.51
Sole	.00	.00	.00	.00	.00	.00	.00	.38	.19	.05	.00	.03	.02	.00
Lemon sole	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Dab	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00
Mackerel	.00	.00	.00	.05	.22	.29	.05	.00	.00	.00	.00	.00	.00	.00
Poor cod	.00	.00	.12	.00	.00	.69	4.90	.00	.00	.52	.00	.00	6.43	2.61
Silvery pout	.00	.00	.00	.28	.11	.01	.07	.00	.00	.00	.50	.34	.09	.03
Unidentified rockling	.00	.12	.00	.00	.03	.00	.00	.02	.29	.00	.00	.08	.00	.00
Unidentified gadoids	3.00	.00	.00	.00	.00	.00	.00	.19	.00	.00	.00	.00	.00	.00
Hake	.00	.00	.05	.00	.00	.00	.00	.00	.00	.20	.00	.00	.00	.00
Unidentified clupeoid	.00	.34	.00	.00	.00	.00	.02	7.89	.81	.00	.00	.00	.03	.01
Witch	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00
Long rough dab	.00	.04	.01	.05	.31	.17	1.17	.05	.08	.03	.09	.99	1.54	.62
Unidentified flatfish	.02	.00	.00	.00	.00	.00	.00	.03	.00	.00	.00	.00	.00	.00
Wolf fish	.00	.00	.00	.01	.01	.00	.00	.00	.00	.00	.02	.02	.00	.00
Pearl-side	.00	.02	.03	.04	.06	.00	.00	.00	.04	.13	.07	.20	.00	.00
Argentines	.00	.00	.00	.00	.08	.24	1.69	.00	.00	.00	.00	.25	2.22	.90
Dragonet	.00	.05	.03	.07	.07	.13	.95	.21	.12	.13	.13	.21	1.24	.50
Scad	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.02	.00	.00
Norway haddock	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.05	.00	.00
Lesser weever	.00	.00	.00	.04	.00	.00	.00	.01	.00	.00	.08	.00	.00	.00
Stickleback	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Unidentified gurnards	.00	.00	.00	.00	.08	.00	.00	.00	.00	.00	.00	.27	.00	.00
Unidentified blennies	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.04	.00	.00	.00
Unidentified gobies	.95	2.02	.40	.22	.29	.00	.00	4.25	4.79	1.67	.39	.93	.01	.00
Unidentified prey	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.54

Table 5a

Diet (% by weight) of saithe by length in winter and summer (Daan, 1989)

Size lower limit (cm)	25	30	40	50	70	100	25	30	40	50	70	100
	Winter						Summer					
Cnidaria	0	0	0	0	0	.93	0	0	0	0	0	0
Annelida	0	0	0	.02	0	0	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	.03	0	0	0	0	0	0
Cephalopoda	29.79	9.69	0	.85	.8	.14	0	.22	0	0	.49	0
Copepoda	0	0	0	0	0	0	0	.01	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0	0	.01	0	0
Amphipoda	0	0	0	0	.01	0	0	0	.73	.07	.01	0
Euphausiacea	0	47.78	76.43	21.1	9.35	.12	0	28.15	37.13	45.66	33.26	13.48
Crangonid	0	0	0	0	.01	.01	0	0	0	.01	0	0
Pandalid	0	0	0	0	.33	0	0	0	0	0	0	0
Other Caridea	0	0	0	0	0	0	0	0	0	0	.34	0
Anomura	0	0	0	0	0	.05	0	0	0	0	0	0
Brachyura	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata	0	0	0	.01	0	.02	0	0	0	0	.03	0
Urochordata	0	0	0	0	.01	0	0	0	0	0	.06	0
Cod	0	0	0	0	0	0	0	.38	0	.78	.39	0
Haddock	0	9.92	2.84	5.92	3.67	4.93	0	35.16	3.89	5.36	12.7	31.82
Whiting	0	0	0	0	1.01	8.16	0	0	.46	.3	0	0
Norway pout	0	10.89	11.47	67.44	75.49	74.23	0	1.67	39.55	21.72	29.25	14.36
Herring	0	0	0	.7	1.88	0	0	0	0	1.11	.44	17.29
Sprat	0	0	7.52	0	.32	0	0	.3	0	0	0	0
Sandeels	70.21	21.72	0	0	.81	3.42	100	31.79	1.98	.47	1.88	0
Dab	0	0	0	0	.34	1.18	0	0	0	0	0	0
Other fish	0	0	1.74	3.96	5.97	6.78	0	2.32	16.26	24.51	21.15	23.05

Table 5b

Saithe quarterly age/length keys (Daan, 1989)

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
Length (cm)	Quarter 1							Quarter 2						
25 to 30	.00	.16	.00	.00	.00	.00	.00	.00	.07	.00	.00	.00	.00	.00
30 to 40	.00	.84	.94	.75	.00	.00	.00	.00	.93	.82	.19	.00	.00	.00
40 to 50	.00	.00	.06	.20	.03	.00	.00	.00	.00	.17	.70	.42	.00	.00
50 to 70	.00	.00	.00	.05	.94	.25	.02	.00	.00	.01	.11	.57	.63	.20
70 to 100	.00	.00	.00	.00	.03	.75	.97	.00	.00	.00	.00	.01	.37	.79
>=100	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.01
	Quarter 3							Quarter 4						
25 to 30	.00	.03	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00
30 to 40	.00	.97	.81	.48	.01	.01	.00	.00	.98	.73	.33	.00	.00	.00
40 to 50	.00	.00	.19	.42	.06	.00	.00	.00	.00	.25	.49	.02	.00	.00
50 to 70	.00	.00	.00	.10	.90	.73	.23	.00	.00	.02	.18	.91	.63	.03
70 to 100	.00	.00	.00	.00	.03	.26	.76	.00	.00	.00	.00	.07	.37	.96
>=100	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.01

Table 5c

Diet (% by weight) of saithe by age and quarter (Daan, 1989)

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 1							Quarter 2						
Cnidaria	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00
Annelida	.00	.00	.00	.00	.02	.01	.00	.00	.00	.00	.00	.00	.00	.00
Gastropoda	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cephalopoda	.00	12.91	9.11	7.31	.82	.81	.79	.00	.20	.18	.04	.00	.18	.39
Copepoda	.00	.00	.00	.00	.00	.00	.00	.00	.01	.01	.00	.00	.00	.00
Isopoda	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.01	.00
Amphipoda	.00	.00	.00	.00	.00	.01	.01	.00	.00	.12	.52	.35	.05	.02
Euphausiacea	.00	40.14	49.50	52.18	22.41	12.29	9.49	.00	26.18	29.85	36.36	41.95	41.07	35.54
Crangonid	.00	.00	.00	.00	.00	.01	.01	.00	.00	.00	.00	.01	.01	.00
Pandalid	.00	.00	.00	.00	.01	.25	.32	.00	.00	.00	.00	.00	.00	.00
Other Caridea	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.13	.27
Anomura	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Brachyura	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Echinodermata	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.01	.02
Urochordata	.00	.00	.00	.00	.00	.01	.01	.00	.00	.00	.00	.00	.02	.05
Cod	.00	.00	.00	.00	.00	.00	.00	.00	.35	.32	.16	.45	.64	.46
Haddock	.00	8.33	9.50	8.30	5.76	4.23	3.73	.00	32.70	29.55	9.99	4.82	8.08	11.42
Whiting	.00	.00	.00	.00	.03	.76	1.06	.00	.00	.08	.36	.36	.19	.06
Norway pout	.00	9.15	10.92	13.83	66.00	73.48	75.32	.00	1.55	8.31	30.39	29.28	24.51	27.60
Herring	.00	.00	.00	.04	.71	1.59	1.84	.00	.00	.01	.12	.64	.86	.74
Sprat	.00	.00	.45	1.50	.24	.24	.31	.00	.28	.25	.06	.00	.00	.00
Sandeels	.00	29.48	20.42	16.29	.02	.61	.82	.00	36.56	26.41	7.48	1.12	.99	1.58
Dab	.00	.00	.00	.00	.01	.26	.34	.00	.00	.00	.00	.00	.00	.00
Other fish	.00	.00	.10	.55	3.95	5.47	5.94	.00	2.16	4.91	14.52	21.01	23.27	21.84
	Quarter 3							Quarter 4						
Cnidaria	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01
Annelida	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.01	.00
Gastropoda	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Cephalopoda	.21	.21	.18	.11	.02	.13	.37	10.09	10.09	7.09	3.35	.83	.83	.79
Copepoda	.01	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Isopoda	.00	.00	.00	.00	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00
Amphipoda	.00	.00	.14	.31	.11	.05	.02	.00	.00	.00	.00	.00	.00	.01
Euphausiacea	27.31	27.31	29.86	33.67	44.60	42.26	35.91	46.82	46.82	54.41	57.02	21.38	16.75	9.61
Crangonid	.00	.00	.00	.00	.01	.01	.00	.00	.00	.00	.00	.00	.00	.01
Pandalid	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.12	.32
Other Caridea	.00	.00	.00	.00	.01	.09	.26	.00	.00	.00	.00	.00	.00	.00
Anomura	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Brachyura	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Echinodermata	.00	.00	.00	.00	.00	.01	.02	.00	.00	.00	.00	.01	.01	.00
Urochordata	.00	.00	.00	.00	.00	.02	.05	.00	.00	.00	.00	.00	.00	.01
Cod	.37	.37	.31	.26	.72	.67	.48	.00	.00	.00	.00	.00	.00	.00
Haddock	34.11	34.11	29.22	19.05	5.79	7.57	11.20	9.72	9.72	8.07	5.73	5.70	5.09	3.75
Whiting	.00	.00	.09	.22	.30	.22	.07	.00	.00	.00	.00	.07	.37	1.05
Norway pout	1.62	1.62	8.87	19.58	22.82	23.48	27.37	10.67	10.67	12.17	21.35	66.88	70.42	75.24
Herring	.00	.00	.00	.11	1.01	.92	.76	.00	.00	.01	.13	.77	1.14	1.83
Sprat	.29	.29	.24	.14	.00	.00	.00	.00	.00	1.88	3.68	.17	.12	.31
Sandeels	33.84	33.84	26.13	16.14	.92	1.15	1.54	22.69	22.69	15.86	7.17	.06	.30	.81
Dab	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	.13	.34
Other fish	2.25	2.25	4.97	10.39	23.69	23.41	21.94	.00	.00	.51	1.57	4.06	4.70	5.92

Table 6

Mean stomach contents weight (Daan, 1989), fish length and weight (MSVPA output), and daily ration estimated using Jones' (1974) digestion model for four gadoid species, by age and quarter

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
Cod	**Quarter 1**							**Quarter 2**						
Stomach weight (g)	.0	.9	5.7	28.7	66.8	82.0	123.9	.0	2.5	11.4	41.2	94.9	116.1	160.5
Mean Fish Len (cm)	.0	15.5	36.0	50.5	66.3	79.1	92.5	1.8	21.1	39.2	57.2	72.8	83.4	96.9
Mean Fish Wght (g)	0	52	576	1510	3300	5450	8592	0	116	682	2000	3990	5870	9085
Daily ration (g)	.0	.8	5.7	19.2	41.5	58.3	87.9	.0	2.0	9.6	29.3	60.2	79.9	114.5
Daily ration (%BW)	.00	1.45	.99	1.27	1.26	1.07	1.02	.00	1.71	1.40	1.46	1.51	1.36	1.26
Cod	**Quarter 3**							**Quarter 4**						
Stomach weight (g)	.2	4.3	14.8	40.7	107.8	140.2	318.0	.9	6.7	13.1	37.7	94.4	104.1	137.3
Mean Fish Len (cm)	7.4	26.4	41.4	59.0	75.3	86.5	96.9	11.5	30.7	45.0	60.8	76.2	87.7	95.8
Mean Fish Wght (g)	6	230	829	2280	4580	6810	9499	23	377	1120	2650	5040	7530	9767
Daily ration (g)	.2	4.5	14.8	38.7	85.3	116.9	199.8	.6	5.8	13.4	33.2	69.4	88.4	113.7
Daily ration (%BW)	3.28	1.94	1.78	1.70	1.86	1.72	2.10	2.49	1.53	1.20	1.25	1.38	1.17	1.16
Haddock	**Quarter 1**							**Quarter 2**						
Stomach weight (g)	.00	.27	.98	1.93	3.30	6.42	6.91	.24	.37	1.91	5.18	8.78	10.34	10.48
Mean Fish Len (cm)	.0	17.1	26.6	33.5	38.6	43.2	48.9	4.2	20.0	28.9	35.3	40.4	45.0	50.6
Mean Fish Wght (g)	0	55	191	367	548	754	1081	1	82	231	408	595	809	1137
Daily ration (g)	.00	.49	1.65	3.12	4.87	7.75	9.54	.07	.77	2.74	5.74	8.83	11.08	13.14
Daily ration(%BW)	.00	.89	.87	.85	.89	1.03	.88	7.11	.94	1.18	1.41	1.48	1.37	1.16
Haddock	**Quarter 3**							**Quarter 4**						
Stomach weight (g)	.17	1.52	3.32	6.01	10.31	18.41	15.12	.30	1.21	2.65	4.99	7.49	9.11	9.34
Mean Fish Len (cm)	9.3	22.0	29.8	35.6	40.4	44.8	50.0	13.4	21.9	31.1	36.1	40.7	44.8	49.8
Mean Fish Wght (g)	10	115	274	452	646	863	1191	30	122	327	500	700	919	1250
Daily ration (g)	.23	2.14	4.71	7.93	12.13	18.28	19.50	.43	1.64	3.83	6.32	9.00	11.26	13.22
Daily ration (%BW)	2.34	1.86	1.72	1.75	1.88	2.12	1.64	1.44	1.34	1.17	1.26	1.29	1.23	1.06
Whiting	**Quarter 1**							**Quarter 2**						
Mean Stomach Wght (g)	.00	.44	.91	1.87	2.91	3.57	4.77	.00	.71	1.68	3.06	2.68	2.74	3.90
Mean Fish Len (cm)	.0	15.9	23.6	28.1	31.9	34.4	36.9	4.8	19.6	26.4	30.4	34.2	36.6	38.9
Mean Fish Wght (g)	0	39	125	210	304	381	466	1	64	153	232	327	400	479
Daily ration (g)	.00	.56	1.35	2.41	3.53	4.31	5.43	.00	1.01	2.27	3.65	4.04	4.50	5.78
Daily ration (%BW)	.00	1.43	1.08	1.15	1.16	1.13	1.17	.00	1.59	1.49	1.57	1.24	1.12	1.21
Whiting	**Quarter 3**							**Quarter 4**						
Mean Stomach Wght (g)	.00	.92	2.44	3.71	4.53	5.57	4.79	.00	1.06	1.82	2.85	3.60	4.83	4.96
Mean Fish Len (cm)	9.3	21.1	27.1	31.1	34.5	37.1	39.0	12.7	22.3	27.6	31.3	34.3	36.5	38.7
Mean Fish Wght (g)	7	81	170	254	345	425	493	19	102	190	277	362	435	512
Daily ration (g)	.17	1.60	3.58	5.25	6.66	8.09	8.11	.35	1.58	2.72	4.00	5.06	6.32	6.92
Daily ration (%BW)	2.38	1.98	2.11	2.07	1.93	1.90	1.64	1.86	1.55	1.43	1.44	1.40	1.45	1.35
Saithe	**Quarter 1**							**Quarter 2**						
Mean Stomach Wght (g)	.0	4.29	4.64	6.53	22.20	37.00	41.79	.00	4.41	5.32	9.28	13.63	27.44	40.97
Mean Fish Len (cm)	.0	12.0	25.4	41.9	50.8	58.1	73.0	.0	13.9	27.3	46.1	54.1	61.6	76.2
Mean Fish Wght (g)	0	26	200	793	1340	1940	3730	0	36	231	965	1500	2140	3941
Daily ration (g)	.0	1.08	3.17	7.50	17.21	26.31	38.26	.00	1.44	4.06	10.89	16.28	26.94	43.66
Daily ration (%BW)	.00	4.14	1.58	.95	1.28	1.36	1.03	.00	4.00	1.76	1.13	1.09	1.26	1.11
Saithe	**Quarter 3**							**Quarter 4**						
Mean Stomach Wght (g)	.00	4.35	5.31	7.69	16.46	23.93	40.04	.00	4.22	6.36	10.92	23.11	29.36	41.59
Mean Fish Len (cm)	6.6	20.6	34.7	47.5	54.9	62.9	76.7	10.8	24.1	38.7	48.4	55.7	63.0	76.3
Mean Fish Wght (g)	5	111	463	1090	1620	2360	4151	20	183	667	1230	1800	2530	4363
Daily ration (g)	.16	3.17	7.22	13.27	23.06	33.21	55.47	.46	3.33	7.79	13.65	23.42	31.11	47.72
Daily ration (%BW)	3.20	2.86	1.56	1.22	1.42	1.41	1.34	2.30	1.82	1.17	1.11	1.30	1.23	1.09

Table 7

MSVPA output, numbers (X1000) at age of four gadoid species: "O" group 1 July, other age groups 1 January

Age	Cod	Whiting	Haddock	Saithe
0	895185	11491864	29510040	267464
1	356453	3054320	5308307	283283
2	150282	741456	763655	242374
3	40358	284566	207912	174564
4	11578	119665	77136	92152
5	4611	41814	23664	36260
6	1872	12921	5552	10215
7	832	3294	1743	4370
8	320	777	649	2025
9	135	126	325	1076
10	55	32	174	588
11	39	-	127	384
12	-	-	-	234
13	-	-	-	173
14	-	-	-	119
15	-	-	-	209

Table 8

Numbers (X1000) of the four gadoid species, by age and quarter (MSVPA derived)

Age	Quarter															
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	Cod	Cod	Cod	Cod	Whiting	Whiting	Whiting	Whiting	Haddock	Haddock	Haddock	Haddock	Saithe	Saithe	Saithe	Saithe
0	0	0	516517	405690	0	0	8364500	6097826	0	0	6304447	47261120	0	0	391748	335805
1	318642	250272	196572	154394	4445391	324074	62362545	1722325	3542917	2655938	1991017	1492561	287851	246745	211509	181305
2	121266	95246	74810	58758	1255596	915345	667298	486469	1118894	838776	628786	471368	155414	133221	114196	97889
3	46150	36248	28470	22362	354642	258538	188478	137403	353360	264895	198578	148863	83910	71928	61656	52851
4	17563	13795	10835	8510	100168	73024	53235	38809	111595	83657	62713	47013	45304	38835	33289	28535
5	6684	5250	4123	3239	28292	20626	15036	10962	35243	26420	19806	14847	24460	20967	17973	15406
6	2544	1998	1569	1233	7991	5826	4247	3096	11130	8344	6255	4689	13206	11320	9704	8318
7	968	760	597	469	2257	1645	1200	874	3515	2635	1975	1481	7130	6112	5239	4491
8	368	289	227	179	638	465	339	247	1110	832	624	468	3850	3300	2829	2425
9	140	110	86	68	180	131	96	70	351	263	197	148	2079	1782	1527	1309
10	53	42	33	26	51	37	27	20	111	83	62	47	1122	962	825	707
11	20	16	13	10	-	-	-	-	35	26	20	15	606	519	445	382
12	-	-	-	-	-	-	-	-	-	-	-	-	327	280	240	206
13	-	-	-	-	-	-	-	-	-	-	-	-	177	151	130	111
14	-	-	-	-	-	-	-	-	-	-	-	-	95	82	70	60
15	-	-	-	-	-	-	-	-	-	-	-	-	51	44	38	32

Table 9

Biomass (tonnes) of the four gadoid species, by age and quarter (MSVPA derived)

Age	Quarter															
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	Cod	Cod	Cod	Cod	Whiting	Whiting	Whiting	Whiting	Haddock	Haddock	Haddock	Haddock	Saithe	Saithe	Saithe	Saithe
0	0	0	3099	9128	0	0	61061	117078	0	0	63044	141783	0	0	1959	6716
1	16538	29032	45211	58206	173370	205787	191602	175677	194860	217787	228967	182092	7484	8883	23478	33179
2	69849	64958	62017	65809	156950	140048	113441	92429	213709	193757	172287	154137	31083	30774	52873	65292
3	69687	72496	64912	59258	74475	59981	47873	38061	129683	108077	89757	74432	66541	69410	67205	65007
4	57960	55042	49624	42891	30451	23879	18366	14049	61154	49776	40513	32909	60707	58252	53928	51363
5	36429	30817	28081	24388	10779	8250	6390	4768	26573	21374	17092	13645	47453	44870	42416	38978
6	19740	16344	13166	10748	3556	2651	1992	1511	10841	8594	6755	5298	36318	33509	30761	28282
7	8713	7459	6450	5113	1144	867	650	484	4183	3267	2568	2044	25883	23593	21376	19222
8	4016	3241	2637	2124	360	268	203	156	1621	1273	1004	790	17247	15444	13833	12342
9	1711	1377	1107	883	120	92	70	53	621	486	374	287	11016	9817	8736	7776
10	710	566	451	362	40	30	23	17	218	166	129	101	6913	6137	5434	4785
11	288	228	182	145	-	-	-	-	79	62	49	38	4217	3708	3250	2836
12	-	-	-	-	-	-	-	-	-	-	-	-	2476	2159	1889	1657
13	-	-	-	-	-	-	-	-	-	-	-	-	1452	1273	1111	966
14	-	-	-	-	-	-	-	-	-	-	-	-	838	728	631	544
15	-	-	-	-	-	-	-	-	-	-	-	-	469	404	348	300

Table 10

Partitioning Sparholt (1990) total gadoid biomass (tonnes) in each quarter by age using MSVPA derived proportions of biomass at age

Age	Quarter															
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	Cod	Cod	Cod	Cod	Whiting	Whiting	Whiting	Whiting	Haddock	Haddock	Haddock	Haddock	Saithe	Saithe	Saithe	Saithe
0	0	0	2555	6935	0	0	60784	127018	0	0	58703	147721	0	0	2993	10215
1	15111	25228	37276	44220	136392	185053	190732	190591	143221	189588	213198	189718	11153	14088	35869	50466
2	63824	56446	51133	49995	123474	125937	112926	100276	157075	168669	160422	160592	46319	48806	80780	99311
3	63676	62997	53520	45019	5590	5937	4766	4122	9536	9403	8356	77549	99157	110081	102677	98878
4	52960	47830	40915	32585	2956	2473	1823	1522	4498	4331	3773	34287	90465	92385	82392	78125
5	33286	26779	23153	18527	880	719	636	517	1951	1866	1595	14216	70713	71162	64805	59287
6+	32143	25386	19782	14719	407	314	292	240	1298	1206	1010	8916	159193	153478	133484	119718
Sum	2610002	244666	228333	212000	355000	397333	439666	482000	473000	526333	579666	633000	477000	490000	503000	516000

Table 11

Total quantity (tonnes) of food consumed per day by each age group of four gadoid fish in each quarter

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 1							**Quarter 2**						
Cod	0	219	629	810	666	356	329	0	432	792	922	722	364	320
Haddock	0	1273	1361	811	399	201	114	0	1775	1998	1324	643	255	139
Whiting	0	1948	1336	672	278	96	48	0	2940	1870	849	266	83	42
Saithe	0	462	734	938	1162	959	1633	0	563	857	1242	1003	896	1700
	Quarter 3							**Quarter 4**						
Cod	84	724	912	909	762	397	416	173	678	598	564	449	218	171
Haddock	1371	3969	2755	1466	708	337	166	2129	2546	1881	980	441	174	94
Whiting	1444	3773	2378	986	353	121	48	2361	2952	1437	596	213	75	33
Saithe	96	1026	1260	1250	1173	912	1784	235	918	1159	1097	1016	729	1310

Table 12

Tonnes of each prey species consumed daily in each quarter by cod of different age

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 1							Quarter 2						
Phaeophyta	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Porifora	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cnidaria	.0	.3	.8	.8	.6	.3	.1	.0	.4	1.4	.6	.7	.4	.1
Annellida	.0	19.4	55.2	40.6	18.2	8.0	4.6	.0	39.0	45.5	39.5	27.4	14.4	18.7
Gastropoda	.0	7.2	11.1	4.0	2.3	1.1	1.0	.0	5.8	8.0	1.4	.4	.2	.0
Bivalvia	.0	14.9	34.3	8.3	1.7	.6	.5	.0	10.2	5.9	1.1	.1	.0	.0
Scaphopoda	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cephalopoda	.0	4.8	12.1	6.7	3.7	1.7	1.1	.0	1.0	.4	.6	1.0	.5	.4
Pycnogonida	.0	1.0	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Mysidia	.0	1.5	.7	.1	.0	.0	.0	.0	1.4	.2	.0	.0	.0	.0
Cumacea	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Valvifera	.0	.3	.4	.6	.1	.0	.0	.0	1.9	.5	.1	.0	.0	.0
Gammaridea	.0	2.2	.6	.1	.0	.0	.0	.0	.5	.1	.0	.0	.0	.0
Hyperiidea	.0	.5	2.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Euphausiacea	.0	4.4	7.5	.7	.1	.0	.0	.0	48.3	58.1	63.7	77.8	38.8	10.0
Crangonidae	.0	39.8	12.6	4.5	1.7	.7	.3	.0	18.7	5.9	.5	.0	.0	.1
Other caridea	.0	24.7	25.4	8.1	2.4	.9	.4	.0	13.6	13.5	4.1	.7	.2	.5
Nephrops	.0	1.7	4.1	14.6	23.2	13.4	7.1	.0	.3	13.8	61.1	72.9	41.2	60.1
Anomura	.0	26.3	59.8	25.5	8.3	3.4	3.1	.0	44.6	46.8	17.7	3.4	1.1	.3
Oxystomata	.0	.0	.3	.1	.0	.0	.0	.0	.2	.2	.0	.0	.0	.0
Oxyrhyncha	.0	.7	10.9	5.3	1.0	.3	.1	.0	2.6	9.9	8.9	1.7	.4	.1
Cancridea	.0	.2	7.2	8.7	6.4	3.4	3.1	.0	7.7	63.4	120.5	88.6	42.5	24.0
Brachyrhyncha	.0	6.0	72.6	66.6	23.8	10.2	7.4	.0	27.4	64.9	55.1	33.7	15.7	7.5
Sipuncula	.0	.2	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0
Echiura	.0	.2	6.0	4.4	.7	.1	.0	.0	1.5	.2	.0	.0	.0	.0
Priapulida	.0	.1	.3	.1	.0	.0	.0	.0	.3	.4	.1	.0	.0	.0
Echinodermata	.0	.3	4.8	7.7	2.5	.9	.4	.0	6.8	35.4	20.0	1.9	.0	.0
Chaetognatha	.0	.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Urochordata	.0	.0	.1	.0	.0	.0	.0	.0	.3	.4	.0	.0	.0	.0
Cephalochordata	.0	.0	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cod	.0	.0	6.5	24.9	63.6	38.9	31.2	.0	4.3	10.8	37.2	55.8	28.2	7.0
Haddock	.0	1.7	23.9	70.5	123.5	71.4	26.6	.0	7.6	24.7	50.5	41.4	19.6	6.1
Whiting	.0	.2	45.9	174.0	190.5	105.7	98.2	.0	.3	18.8	58.4	62.3	35.1	52.9
Norway pout	.0	7.9	24.0	37.4	23.7	11.3	4.7	.0	5.4	21.1	39.0	31.5	14.9	4.8
Herring	.0	.3	18.3	44.0	20.4	8.7	8.7	.0	.9	9.5	22.9	29.1	14.8	6.4
Sprat	.0	19.3	52.8	39.1	20.4	9.8	8.8	.0	5.8	27.2	18.3	6.4	3.1	7.3
Sandeels	.0	2.4	56.0	101.5	19.4	2.5	.5	.0	141.7	198.8	106.5	49.4	21.5	8.9
Plaice	.0	.0	.1	1.3	6.3	4.5	12.3	.0	.0	.5	1.3	.6	.7	5.0
Sole	.0	.0	.8	.5	2.6	1.6	.5	.0	.0	.6	.4	.0	.0	.0
Lemon sole	.0	.0	.0	.2	2.1	1.9	12.1	.0	.0	.0	.0	.0	.0	.0
Dab	.0	.8	20.5	59.3	52.4	29.7	54.5	.0	2.4	35.6	92.4	55.8	26.8	27.5
Mackerel	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Long rough dab	.0	7.3	12.3	12.3	11.0	6.2	10.4	.0	7.8	17.4	25.0	20.0	11.0	18.1
Dragonets	.0	7.3	12.3	12.3	11.0	6.2	10.4	.0	7.8	17.4	25.0	19.9	11.0	18.1
Unidentified gobies	.0	14.6	24.7	24.5	21.9	12.4	20.7	.0	15.7	34.9	50.0	40.0	22.1	36.1
Unidentified prey	.0	.0	.0	.0	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 3							Quarter 4						
Phaeophyta	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Porifora	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cnidaria	.0	.0	.1	.1	.1	.0	.0	.0	.5	.4	.3	.2	.1	.0
Annellida	.9	39.8	50.7	62.2	68.8	34.5	5.5	7.1	48.8	47.5	25.0	7.8	3.1	2.4
Gastropoda	.0	11.8	6.6	1.5	.2	.1	.0	1.2	8.5	4.5	3.3	2.7	1.3	.2
Bivalvia	4.9	.4	6.8	4.8	.7	.1	.0	.5	11.0	4.2	.9	.1	.0	.0
Scaphopoda	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cephalopoda	.0	.1	2.4	1.3	1.0	.6	.6	1.0	3.6	3.1	27.7	36.2	18.2	10.3
Pycnogonida	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Mysidia	.6	.1	.0	.0	.0	.0	.0	.7	.1	.0	.0	.0	.0	.0
Cumacea	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Valvifera	.0	2.1	.1	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0
Gammaridea	2.7	.0	.0	.0	.0	.0	.0	.1	1.3	.4	.0	.0	.0	.0
Hyperiidea	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Euphausiacea	.0	69.9	72.2	50.6	8.3	.6	.0	.1	.3	.1	.0	.0	.0	.0
Crangonidae	34.7	6.0	3.3	2.1	2.2	1.2	.1	68.0	80.2	37.4	10.2	.5	.1	.0
Other Caridea	4.3	6.7	5.4	2.4	.3	.1	.0	13.4	12.3	7.0	2.9	1.0	.4	.1
Nephrops	.0	7.4	47.6	93.1	95.3	48.2	29.7	.0	19.7	20.2	16.2	10.4	5.0	.8
Anomura	1.8	61.0	33.3	14.7	3.7	1.2	.1	17.2	62.0	33.9	14.2	5.7	2.5	1.5
Oxystomata	.0	1.2	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Oxyrhyncha	.0	5.3	13.6	11.0	2.5	.6	.1	.2	5.5	3.0	1.2	.4	.2	.0
Cancridea	.3	25.0	30.9	25.9	10.0	3.6	.4	.4	11.2	11.0	8.8	5.9	2.8	2.4
Brachyrhyncha	11.3	115.9	98.6	60.9	33.5	16.9	22.2	20.9	143.8	167.9	96.2	32.5	13.1	6.3
Sipuncula	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Echiura	.0	.0	.0	.0	.0	.0	.0	.4	3.0	1.3	.3	.0	.0	.0
Priapulida	.0	.2	.1	.0	.0	.0	.0	.1	23.5	9.3	1.9	.0	.0	.0
Echinodermata	.1	1.9	7.7	7.5	4.2	1.8	.3	.0	.5	.4	.2	.0	.0	.0
Chaetognatha	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Urochordata	.0	.0	.0	.0	.0	.0	.0	.3	.1	.1	.0	.0	.0	.0
Cephalochordata	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cod	.0	58.4	24.0	9.6	11.5	5.7	.7	.2	.3	1.8	31.7	42.1	21.3	5.2
Haddock	.0	39.8	78.2	92.7	89.6	54.8	128.3	2.0	67.0	50.4	69.9	69.8	34.9	47.5
Whiting	.8	88.9	50.2	27.7	22.8	11.7	7.2	.0	5.4	9.6	57.8	72.8	36.7	25.7
Norway pout	.0	21.6	161.5	209.0	157.4	72.8	12.4	1.7	44.5	49.6	42.4	29.4	13.8	4.8
Herring	.0	31.3	53.6	77.3	102.9	52.7	6.2	.0	14.6	11.7	9.9	7.3	3.7	.5
Sprat	.0	15.7	25.8	7.9	.2	.0	.0	.1	2.7	5.4	5.1	3.5	1.6	.2
Sandeels	.7	58.4	61.0	28.3	5.8	1.9	.2	5.8	33.5	15.6	23.5	26.7	13.4	13.2
Plaice	.0	.6	.2	.0	.0	4.8	53.1	.0	.0	.3	.2	.0	.0	.3
Sole	.0	.6	.2	.6	1.2	.8	1.0	.0	.9	1.4	.8	.3	.1	1.7
Lemon sole	.0	.0	.7	.9	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
Dab	2.1	9.4	21.4	38.1	44.3	22.2	3.4	2.4	12.4	12.9	38.7	45.5	22.8	41.1
Mackerel	.0	.0	.1	8.0	16.2	10.0	18.0	.0	.5	37.8	27.6	9.8	3.7	.5
Long rough dab	4.6	11.0	13.9	17.5	19.8	12.7	31.7	7.3	14.9	12.6	11.9	9.6	4.7	1.6
Dragonets	4.6	11.0	13.9	17.5	19.8	12.7	31.7	7.3	14.9	12.6	11.9	9.6	4.7	1.6
Unidentified gobies	9.3	22.1	27.8	35.0	39.7	25.3	63.3	14.6	30.4	25.1	23.7	19.1	9.3	3.2
Unidentified prey	.0	.3	.1	.2	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0

Table 13

Tonnes of each prey species consumed daily in each quarter by haddock of different age

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 1							Quarter 2						
Cnidaria	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Ctenophora	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Rhynchocoela	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Annellida	.0	331.0	259.5	95.0	36.5	23.2	13.7	.0	304.4	144.8	68.9	28.3	10.0	5.4
Gastropoda	.0	21.1	22.2	7.5	4.8	3.3	2.0	.0	.0	2.2	3.8	1.9	2.3	1.4
Polyplacophora	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Bivalvia	.0	33.6	98.8	42.8	11.5	2.8	1.5	.0	93.2	79.5	34.6	14.3	4.5	2.4
Scaphopoda	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.3	.1	.0	.0
Cephalopoda	.0	100.9	25.6	9.4	5.2	1.4	.7	.0	.4	16.6	8.3	.9	.0	.0
Pycnogonida	.0	.1	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Calanoida	.0	.0	.0	.0	.0	.0	.0	.0	23.4	31.0	17.6	6.6	2.0	1.1
Leptostraca	.0	.1	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Mysidia	.0	.5	.5	.2	.0	.0	.0	.0	1.1	.0	.0	.0	.0	.0
Cumacea	.0	.8	.7	.3	.1	.0	.0	.0	1.2	.2	.0	.0	.0	.0
Tanaidacea	.0	3.2	1.0	.6	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0
Flabellifera	.0	37.7	41.4	17.2	8.5	3.2	1.7	.0	3.0	12.4	4.4	1.2	.3	.3
Valvifera	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Asellota	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Gammaridea	.0	54.9	32.1	12.2	3.2	.7	.3	.0	68.0	21.8	4.9	1.1	.2	.1
Hyperiidea	.0	2.7	5.4	1.5	.2	.1	.0	.0	6.2	2.2	2.1	.3	.0	.0
Caprellidea	.0	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Euphausiacea	.0	53.6	34.8	20.0	20.7	14.9	8.7	.0	201.8	263.1	121.6	40.4	12.0	6.4
Crangonidae	.0	6.5	4.5	1.1	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
Caridea	.0	46.5	40.1	13.2	4.0	.7	.3	.0	52.4	38.0	5.4	.8	.6	.3
Anomura	.0	51.2	46.7	27.7	25.7	14.2	8.0	.0	40.8	15.4	19.7	8.5	2.6	1.4
Oxyrhyncha	.0	.3	2.4	1.1	.6	.5	.3	.0	15.8	14.2	2.4	.2	.0	.0
Cancridea	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.0	1.2	.1	.0	.0
Brachyrhyncha	.0	1.0	7.8	2.8	1.9	1.6	1.0	.0	.2	2.8	1.6	.2	.0	.2
Echiura	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Echinodermata	.0	284.6	216.0	127.9	49.7	15.6	8.3	.0	516.4	250.3	127.7	73.5	29.4	16.5
Chaetognatha	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Urochordata	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cephalochordata	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cod	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Haddock	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Whiting	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Norway pout	.0	.0	226.6	197.2	132.8	70.4	39.6	.0	.0	.4	10.9	29.6	17.9	9.6
Herring	.0	.0	.0	.4	5.5	11.4	7.2	.0	.0	.0	.0	.0	.0	.0
Sprat	.0	1.3	20.7	42.3	13.4	3.8	2.1	.0	.0	.0	.7	1.9	.8	.4
Sandeels	.0	1.7	12.5	35.5	29.0	13.6	7.5	.0	.0	.0	.0	.0	.0	.0
Dab	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Long rough dab	.0	43.6	59.9	36.5	8.9	3.4	2.0	.0	49.7	278.1	272.7	135.1	54.6	29.5
Pearl-sides	.0	43.6	59.9	36.5	8.9	3.4	2.0	.0	49.7	278.1	272.7	135.1	54.6	29.5
Unidentified gobies	.0	43.6	59.9	36.5	8.9	3.4	2.0	.0	49.7	278.1	272.7	135.1	54.6	29.5
Unidentified prey	.0	108.6	81.1	45.6	18.8	8.7	5.0	.0	297.7	267.5	70.2	27.6	8.5	5.2

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 3							Quarter 4						
Cnidaria	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
Ctenophora	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
Rhynchocoela	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Annellida	140.0	354.8	168.9	70.1	23.5	7.2	3.9	224.4	287.6	204.8	128.9	50.1	14.0	10.2
Gastropoda	.3	14.7	5.5	5.6	2.6	.5	.5	13.8	9.9	6.6	8.4	3.1	.5	.6
Polyplacophora	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Bivalvia	2.6	124.2	100.0	38.3	12.7	4.2	2.1	53.2	99.3	56.2	20.9	5.4	1.5	.8
Scaphopoda	.0	.0	2.2	1.2	.2	.0	.0	.0	.3	.2	.0	.0	.0	.0
Cephalopoda	.0	4.4	5.0	.7	.1	.0	.0	8.5	26.5	21.1	20.3	7.4	1.2	1.5
Pycnogonida	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Calanoida	.7	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Leptostraca	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Mysidia	5.8	4.4	.8	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0
Cumacea	5.3	.4	.0	.0	.0	.0	.0	15.5	3.3	5.1	2.8	.8	.2	.1
Tanaidacea	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Flabellifera	1.2	21.0	11.8	2.8	.6	.1	.0	12.3	17.3	12.2	3.2	1.2	.6	.2
Valvifera	.0	1.6	1.1	.4	.1	.0	.0	8.5	13.7	2.8	.7	.2	.1	.0
Asellota	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Gammaridea	16.9	19.1	13.2	3.7	.7	.1	.1	24.9	14.5	3.6	1.1	.4	.1	.1
Hyperiidea	1.6	1.6	3.9	4.1	1.8	.4	.3	33.6	187.4	179.2	54.8	23.7	10.9	4.9
Caprellidea	.3	.4	.0	.0	.0	.0	.0	2.3	.0	.0	.0	.0	.0	.0
Euphausiacea	346.0	624.4	555.1	219.0	61.3	13.8	8.5	66.0	1.3	1.3	1.0	2.1	1.6	.6
Crangonidae	6.3	9.5	1.1	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
Caridea	20.1	26.6	13.2	4.8	1.0	.2	.1	116.0	89.6	58.5	15.0	3.0	.8	.3
Anomura	1.9	84.1	29.2	7.6	8.9	9.3	4.4	28.1	72.5	51.3	20.6	18.6	12.4	4.7
Oxyrhyncha	2.1	79.4	44.9	7.8	2.0	.6	.3	29.2	16.5	1.5	.3	.0	.0	.0
Cancridea	.1	2.4	3.0	1.3	.4	.2	1.1	.0	.0	.2	.1	.0	.0	.0
Brachyrhyncha	6.7	8.7	7.2	5.9	3.3	1.1	.7	44.7	74.6	46.3	12.7	4.3	1.9	.8
Echiura	.0	.0	.0	.0	.0	.0	.0	.2	.5	.2	.2	.1	.0	.0
Echinodermata	26.0	377.5	313.5	144.2	49.5	15.8	20.4	263.4	244.6	132.0	60.3	31.2	14.5	7.0
Chaetognatha	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Urochordata	13.8	100.0	34.2	6.7	1.1	.1	.0	.0	.0	.4	1.3	.5	.1	.1
Cephalochordata	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cod	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Haddock	.0	2.4	5.5	6.3	3.0	.6	.5	.0	2.0	1.1	.0	.0	.0	.0
Whiting	.0	.0	.0	.1	.6	.8	.2	.0	.3	1.3	2.8	1.1	.2	.2
Norway pout	2.2	55.2	163.6	182.8	143.5	95.2	37.3	29.6	133.6	128.5	73.9	44.1	21.9	10.3
Herring	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	2.9	1.2	.2	.3
Sprat	.0	.4	4.7	2.6	1.3	1.2	.4	.0	.0	.0	.0	.0	.0	.0
Sandeels	125.3	469.2	338.0	114.0	35.4	8.3	5.4	27.3	119.4	403.6	226.9	90.0	32.4	18.2
Dab	.0	.0	.0	.0	.0	.0	.0	.2	.0	.0	.0	.0	.0	.0
Long rough dab	139.6	442.7	252.6	189.4	110.9	56.8	25.4	282.4	316.7	160.6	97.7	46.8	18.1	10.3
Pearl-sides	139.6	442.7	252.6	189.4	110.9	56.8	25.4	282.4	316.7	160.6	97.7	46.8	18.1	10.3
Unidentified gobies	139.6	442.7	252.6	189.4	110.9	56.8	25.4	282.4	316.7	160.6	97.7	46.8	18.1	10.3
Unidentified prey	226.6	254.4	171.4	66.8	21.6	6.6	3.5	279.7	180.5	80.7	27.3	11.5	4.7	2.4

Table 14

Tonnes of each prey species consumed daily in each quarter by whiting of different age

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 1							Quarter 2						
Porifera	.0	.0	.0	.0	.0	.0	.0	.0	.0	.9	.1	.0	.0	.0
Cnidaria	.0	.0	.0	.0	.0	.0	.0	.0	11.2	5.1	.3	1.5	2.2	.1
Ctenophora	.0	.2	.7	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Nemertea	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.1	.1	.1
Platyhelminthes	.0	.0	.0	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
Annellida	.0	98.4	33.7	6.0	1.1	.4	.1	.0	46.2	37.6	6.8	7.6	2.9	.6
Gastropoda	.0	.2	.3	1.1	.7	.2	.1	.0	.9	1.3	1.1	.4	.0	.0
Bivalvia	.0	1.0	2.1	.6	.0	.0	.0	.0	.3	.9	.1	.1	.0	.0
Cephalopoda	.0	273.5	129.8	30.5	4.4	1.0	.2	.0	93.2	9.7	1.3	1.0	.2	.1
Unidentified molluscs	.0	30.0	14.3	2.3	1.3	.5	.1	.0	.6	.0	.2	.2	.1	.0
Copepoda	.0	2.7	.0	.0	.0	.0	.0	.0	7.3	1.7	.7	.1	.0	.0
Mysidia	.0	1.6	.3	.1	.0	.0	.0	.0	1.8	.2	.1	.1	.0	.0
Cumacea	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Isopoda	.0	2.9	1.9	1.8	.8	.2	.1	.0	3.5	2.6	.4	.1	.0	.0
Amphipoda	.0	6.0	3.1	.5	.1	.0	.0	.0	38.8	1.5	.3	.1	.0	.0
Euphausiacea	.0	268.7	273.8	130.1	40.3	10.4	4.1	.0	994.5	343.0	100.9	18.6	3.9	1.9
Crangonidae	.0	4.5	4.4	1.4	.6	.2	.0	.0	.0	.0	.0	.0	.0	.0
Pandalidae	.0	4.5	2.9	2.9	1.1	.3	.1	.0	.0	2.2	6.1	2.9	.4	.7
Caridea	.0	249.4	54.5	16.9	5.0	1.4	.5	.0	42.0	19.8	18.3	7.6	2.2	1.0
Macrura	.0	62.5	10.8	1.7	.6	.2	.0	.0	2.4	.6	.4	.4	.0	.0
Anomura	.0	5.8	2.9	.5	.3	.1	.0	.0	1.2	7.1	1.0	.8	.0	.0
Brachyura	.0	2.3	.1	.4	1.8	3.6	.9	.0	2.4	.6	4.5	7.5	3.5	.7
Unidentified crustacea	.0	56.9	34.3	6.7	.0	.0	.0	.0	33.8	14.6	.8	3.5	1.3	.0
Echiura	.0	3.9	.4	.3	.2	.1	.0	.0	.6	.0	.0	.0	.0	.0
Priapulida	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Echinodermata	.0	.0	.0	.0	.0	.0	.0	.0	.3	1.1	.4	.1	.0	.0
Chaetognatha	.0	3.3	.1	.0	.0	.0	.0	.0	20.0	7.3	2.7	.4	.0	.1
Appendicularia	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Urochordata	.0	4.1	2.7	.3	.0	.0	.0	.0	71.7	14.2	1.3	1.1	.0	.0
Cod	.0	.0	2.9	.3	.0	.0	1.6	.0	16.5	5.6	5.0	.5	.0	.1
Haddock	.0	22.2	2.9	11.2	6.9	2.5	2.1	.0	.0	7.9	33.0	13.8	2.0	3.5
Whiting	.0	.0	4.4	15.5	15.9	15.1	3.4	.0	.0	10.1	24.1	10.5	2.7	1.2
Norway pout	.0	62.0	73.5	141.3	84.9	28.2	17.5	.0	12.3	138.4	150.3	54.1	26.6	7.1
Herring	.0	.0	163.2	84.0	44.0	9.5	7.6	.0	8.2	15.7	4.4	1.2	.0	.0
Sprat	.0	310.0	382.2	143.1	39.6	11.3	3.5	.0	66.1	42.5	11.1	16.6	3.9	.9
Sandeels	.0	394.1	83.8	32.1	10.1	3.8	2.0	.0	1414.0	1159.1	462.1	101.6	26.9	19.3
Sole	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Lemon sole	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Dab	.0	.0	.3	.6	.4	.2	.0	.0	.0	.0	.3	.3	.0	.0
Mackerel	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	.3	.0	.0
Poor cod	.0	.0	7.9	.0	.0	3.7	2.1	.0	.0	1.9	.0	.0	2.4	2.6
Silvery pout	.0	.0	.0	14.6	1.8	.0	.0	.0	.0	.0	4.2	1.3	.0	.0
Unidentified rocklings	.0	3.7	.0	.0	.4	.0	.0	.0	1.8	.0	.0	.3	.0	.0
Unidentified gadoids	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Hake	.0	.0	3.0	.0	.0	.0	.0	.0	.0	.7	.0	.0	.0	.0
Unidentified clupeoids	.0	10.2	.0	.0	.0	.0	.0	.0	5.0	.0	.0	.0	.0	.0
Witch	.0	.0	.0	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Long rough dab	.0	1.1	.5	2.7	5.1	.9	.5	.0	.5	.1	.8	3.7	.6	.6
Unidentified flatfish	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Wolf fish	.0	.0	.0	.6	.1	.0	.0	.0	.0	.0	.2	.1	.0	.0
Pearl-side	.0	.5	2.1	2.1	1.0	.0	.0	.0	.2	.5	.6	.7	.0	.0
Argentines	.0	.0	.0	.0	1.3	1.3	.7	.0	.0	.0	.0	.9	.8	.9
Dragonet	.0	1.5	2.1	3.8	1.1	.7	.4	.0	.8	.5	1.1	.8	.5	.5
Scad	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.1	.0	.0
Norway haddock	.0	.0	.0	.0	.2	.0	.0	.0	.0	.0	.0	.2	.0	.0
Lesser weever	.0	.0	.0	2.3	.0	.0	.0	.0	.0	.0	.6	.0	.0	.0
Stickleback	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Unidentified gurnards	.0	.0	.0	.0	1.4	.0	.0	.0	.0	.0	.0	1.0	.0	.0
Unidentified blennies	.0	.0	.0	1.1	.0	.0	.0	.0	.0	.0	.3	.0	.0	.0
Unidentified gobies	.0	60.5	25.7	11.3	4.8	.0	.0	.0	29.6	6.3	3.2	3.5	.0	.0
Unidentified prey	.0	.0	8.7	.9	.0	.0	.0	.0	12.1	9.0	.0	.0	.0	.0

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 3							Quarter 4						
Porifera	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cnidaria	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0
Ctenophora	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Nemertea	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Platyhelminthes	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Annellida	158.0	353.1	66.1	5.4	2.3	1.1	.3	138.1	59.6	6.5	1.2	.4	.2	.0
Gastropoda	.0	123.0	6.7	.6	.2	.1	.0	.0	1.8	2.3	.7	.1	.0	.0
Bivalvia	.0	.4	.0	.0	.0	.0	.0	.0	.3	.0	.0	.0	.0	.0
Cephalopoda	.0	.0	.5	1.3	.6	.3	.1	94.4	16.2	6.2	1.6	2.3	.2	2.5
Unidentified molluscs	.0	14.7	4.0	.4	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
Copepoda	342.3	.0	.0	.0	.0	.0	.0	75.8	.3	.0	.0	.0	.0	.0
Mysidia	.0	.0	.0	.0	.0	.0	.0	7.3	3.0	.7	.1	.0	.0	.0
Cumacea	.0	4.5	.5	.4	.2	.0	.0	7.3	1.5	.0	.0	.0	.0	.0
Isopoda	.0	1.5	1.4	.2	.1	.1	.0	1.2	.0	.0	.0	.0	.0	.0
Amphipoda	3.8	6.4	4.8	1.1	.6	.1	.1	29.0	24.8	56.5	28.1	3.3	.6	.6
Euphausiacea	7.5	137.3	117.5	43.0	20.3	2.7	2.0	14.6	.6	5.0	9.2	7.8	3.4	2.2
Crangonidae	725.9	8.3	3.8	.5	.0	.0	.0	428.5	66.7	15.8	1.9	1.4	.4	.0
Pandalidae	.0	.0	.0	.0	.0	.0	.0	7.3	8.3	8.6	1.5	.4	.1	.0
Caridea	71.5	52.1	8.1	1.3	.7	.3	.1	59.3	136.1	20.1	3.7	1.1	.4	.1
Macrura	.0	44.5	2.9	.4	.1	.0	.0	.0	8.6	1.4	.4	.1	.1	.0
Anomura	.0	51.3	5.2	1.0	.9	.4	.1	72.7	88.0	22.0	1.4	1.7	.1	.0
Brachyura	18.8	139.2	38.8	6.0	5.4	2.4	.7	371.8	105.4	12.6	3.3	1.9	2.5	.1
Unidentified crustacea	.0	382.6	61.1	5.4	3.6	1.6	.6	.0	.0	.0	.0	.0	.0	.0
Echiura	3.8	24.1	1.4	.5	.1	.1	.0	21.7	183.3	77.8	.9	4.8	.0	.0
Priapulida	.0	.0	.0	.0	.0	.0	.0	.0	.6	.0	.0	.0	.0	.0
Echinodermata	.0	116.6	3.6	.0	.0	.0	.0	.0	1.8	.0	.0	.0	.0	.0
Chaetognatha	.0	1.1	.0	.0	.0	.0	.0	7.3	18.0	3.4	.5	.1	.0	.0
Appendicularia	.0	.0	.0	.0	.0	.0	.0	22.0	.0	.0	.0	.0	.0	.0
Urochordata	.0	28.3	3.8	.4	.0	.0	.0	.0	36.6	5.7	1.4	.0	.0	.0
Cod	.3	.0	.0	.0	.0	.0	.0	.9	2.7	3.2	2.9	1.3	.5	.2
Haddock	.0	61.9	411.9	227.5	61.5	19.8	9.2	7.1	94.8	155.2	119.3	42.5	18.2	9.7
Whiting	2.0	259.2	158.9	48.3	13.7	5.5	1.9	51.2	89.2	41.8	21.0	5.3	5.1	.9
Norway pout	.3	189.4	198.6	130.1	29.6	6.8	2.6	130.3	281.0	316.1	245.7	79.2	15.7	7.1
Herring	.0	66.0	695.4	289.2	73.4	19.8	6.7	7.1	178.0	86.7	13.2	17.4	8.6	5.2
Sprat	.0	115.1	184.1	95.8	107.2	54.1	15.0	51.7	620.8	227.0	40.5	15.3	4.0	.3
Sandeels	52.9	1494.4	383.8	119.2	27.6	4.0	4.3	446.4	737.7	323.1	89.5	19.3	6.2	1.8
Sole	.0	.0	.0	.0	.0	.0	.0	9.0	5.6	.7	.0	.1	.0	.0
Lemon sole	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Dab	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Mackerel	.0	.0	.0	.5	.8	.4	.0	.0	.0	.0	.0	.0	.0	.0
Poor cod	.0	.0	3.0	.0	.0	.8	2.4	.0	.0	7.4	.0	.0	4.8	.9
Silvery pout	.0	.0	.0	2.8	.4	.0	.0	.0	.0	.0	3.0	.7	.1	.0
Unidentified rocklings	.0	4.6	.0	.0	.1	.0	.0	.5	8.5	.0	.0	.2	.0	.0
Unidentified gadoids	43.3	.0	.0	.0	.0	.0	.0	4.5	.0	.0	.0	.0	.0	.0
Hake	.0	.0	1.1	.0	.0	.0	.0	.0	.0	2.8	.0	.0	.0	.0
Unidentified clupeoids	.0	12.9	.0	.0	.0	.0	.0	186.3	23.9	.0	.0	.0	.0	.0
Witch	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Long rough dab	.0	1.3	.2	.5	1.1	.2	.6	1.2	2.5	.4	.6	2.1	1.2	.2
Unidentified flatfish	.3	.0	.0	.0	.0	.0	.0	.7	.0	.0	.0	.0	.0	.0
Wolf fish	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0
Pearl-side	.0	.6	.8	.4	.2	.0	.0	.0	1.1	1.9	.4	.4	.0	.0
Argentines	.0	.0	.0	.0	.3	.3	.8	.0	.0	.0	.0	.5	1.7	.3
Dragonet	.0	1.9	.8	.7	.2	.2	.5	5.0	3.6	1.9	.8	.4	.9	.2
Scad	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Norway haddock	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.1	.0	.0
Lesser weever	.0	.0	.0	.4	.0	.0	.0	.2	.0	.0	.5	.0	.0	.0
Stickleback	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Unidentified gurnards	.0	.0	.0	.0	.3	.0	.0	.0	.0	.0	.0	.6	.0	.0
Unidentified blennies	.0	.0	.0	.2	.0	.0	.0	.0	.0	.0	.2	.0	.0	.0
Unidentified gobies	13.7	76.3	9.6	2.2	1.0	.0	.0	100.3	141.3	24.1	2.3	2.0	.0	.0
Unidentified prey	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2

Table 15

Tonnes of each prey species consumed daily in each quarter by saithe of different age

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 1							Quarter 2						
Cnidaria	.0	.0	.0	.0	.0	.0	.2	.0	.0	.0	.0	.0	.0	.0
Annelida	.0	.0	.0	.0	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
Gastropoda	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cephalopoda	.0	59.6	66.8	68.5	9.6	7.8	13.0	.0	1.2	1.5	.5	.0	1.6	6.6
Copepoda	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0
Isopoda	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.0
Amphipoda	.0	.0	.0	.0	.0	.1	.2	.0	.0	1.1	6.4	3.5	.4	.4
Euphausiacea	.0	185.2	363.2	489.2	260.4	117.8	155.0	.0	147.4	255.9	451.6	420.7	368.0	604.3
Crangonid	.0	.0	.0	.0	.0	.1	.2	.0	.0	.0	.0	.1	.1	.0
Pandalid	.0	.0	.0	.0	.1	2.4	5.2	.0	.0	.0	.0	.0	.0	.0
Other Caridea	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.1	4.6
Anomura	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Brachyura	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Echinodermata	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.1	.4
Urochordata	.0	.0	.0	.0	.0	.1	.2	.0	.0	.0	.0	.0	.2	.8
Cod	.0	.0	.0	.0	.0	.0	.0	.0	2.0	2.7	2.0	4.5	5.7	7.9
Haddock	.0	38.5	69.7	77.9	66.9	40.6	60.9	.0	184.1	253.2	124.1	48.3	72.4	194.2
Whiting	.0	.0	.0	.0	.4	7.3	17.3	.0	.0	.7	4.4	3.7	1.7	1.0
Norway pout	.0	42.2	80.2	129.7	767.0	704.6	1230.0	.0	8.7	71.2	377.4	293.7	219.6	469.2
Herring	.0	.0	.0	.3	8.3	15.2	30.0	.0	.0	.1	1.5	6.4	7.7	12.6
Sprat	.0	.0	3.3	14.1	2.7	2.3	5.1	.0	1.6	2.1	.7	.0	.0	.0
Sandeels	.0	136.1	149.8	152.7	.3	5.8	13.4	.0	205.9	226.4	92.9	11.2	8.9	26.8
Dab	.0	.0	.0	.0	.1	2.4	5.6	.0	.0	.0	.0	.0	.0	.0
Other fish	.0	.0	.8	5.1	45.9	52.4	97.0	.0	12.1	42.1	180.3	210.7	208.5	371.3
	Quarter 3							Quarter 4						
Cnidaria	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
Annelida	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.1	.0
Gastropoda	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cephalopoda	.2	2.2	2.2	1.3	.2	1.2	6.6	23.7	92.6	82.2	36.8	8.4	6.1	10.4
Copepoda	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Isopoda	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
Amphipoda	.0	.0	1.7	3.9	1.3	.5	.4	.0	.0	.0	.0	.0	.0	.1
Euphausiacea	26.1	280.1	376.1	420.8	523.1	385.4	640.6	110.0	429.7	630.7	625.6	217.3	122.1	125.8
Crangonid	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.1
Pandalid	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.9	4.1
Other Caridea	.0	.0	.0	.0	.1	.8	4.6	.0	.0	.0	.0	.0	.0	.0
Anomura	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Brachyura	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Echinodermata	.0	.0	.0	.0	.0	.1	.4	.0	.0	.0	.0	.1	.0	.0
Urochordata	.0	.0	.0	.0	.0	.1	.8	.0	.0	.0	.0	.0	.0	.1
Cod	.4	3.8	3.9	3.3	8.4	6.2	8.5	.0	.0	.0	.0	.0	.0	.0
Haddock	32.7	349.9	368.0	238.0	67.9	69.0	199.8	22.8	89.2	93.6	62.9	57.9	37.1	49.1
Whiting	.0	.0	1.1	2.8	3.5	2.0	1.2	.0	.0	.0	.0	.7	2.7	13.8
Norway pout	1.6	16.6	111.7	244.8	267.6	214.1	488.2	25.1	97.9	141.0	234.3	679.8	513.4	985.2
Herring	.0	.0	.0	1.4	11.9	8.4	13.6	.0	.0	.2	1.4	7.8	8.3	23.9
Sprat	.3	3.0	3.1	1.8	.0	.0	.0	.0	.0	21.8	40.4	1.8	.9	4.0
Sandeels	32.4	347.1	329.1	201.7	10.7	10.5	27.4	53.3	208.2	183.8	78.7	.6	2.2	10.6
Dab	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.9	4.4
Other fish	2.2	23.1	62.6	129.9	277.9	213.5	391.4	.0	.0	6.0	17.2	41.2	34.3	77.5

Table 16

Diet (% by weight) of plaice by age and quarter (Basimi and Grove, 1985)

Age	0	1	2 & 3	4 - 6	7+	0	1	2 & 3	4 - 6	7+
	Quarter 1					**Quarter 2**				
Pectinaria koreni	.0	57.4	67.3	12.2	.0	.0	3.8	5.2	16.2	.0
Nephtys	.0	.0	.5	5.0	.0	.0	3.5	4.6	3.4	.0
Other polychaetes	.0	25.8	7.3	45.2	.0	.0	2.8	.5	1.1	.0
Abra alba	.0	4.2	7.2	20.5	.0	.0	85.1	88.4	66.1	.0
Cultellus pellucidus	.0	3.0	3.4	2.2	.0	.0	1.9	.7	.6	.0
Ensis ensis	.0	5.6	5.3	9.7	.0	.0	.2	.1	1.3	.0
Other molluscs	.0	4.0	9.0	5.2	.0	.0	2.7	.5	11.3	.0
Upogebia	.0	.0	.0	.0	100.0	.0	.0	.0	.0	100.0
Daily ration (%BW)	.0	2.8	2.9	1.4	1.1	.0	6.5	7.6	2.5	2.0
	Quarter 3					**Quarter 4**				
Pectinaria koreni	23.8	23.8	16.3	20.1	.0	75.8	75.8	74.4	48.8	.0
Nephtys	1.0	1.0	1.2	.9	.0	1.6	1.6	1.5	2.1	.0
Other polychaetes	4.3	4.3	2.0	7.6	.0	2.0	2.0	9.5	28.5	.0
Abra alba	62.5	62.5	75.2	57.3	.0	18.3	18.3	6.3	1.5	.0
Cultellus pellucidus	4.9	4.9	3.2	.0	.0	2.0	2.0	4.3	15.6	.0
Ensis ensis	2.7	2.7	1.2	13.1	.0	.3	.3	3.2	3.4	.0
Other molluscs	.8	.8	.9	1.0	.0	.0	.0	.8	.1	.0
Upogebia	.0	.0	.0	.0	100.0	.0	.0	.0	.0	100.0
Daily ration (%BW)	3.6	3.0	2.3	1.7	1.4	6.3	5.2	2.7	3.7	3.0

Table 17

A; numbers of plaice (x1000) at age ("0" group 1 July, "1+" 1 January; output from MSVPA). B; numbers of plaice (x1000) by age and quarter derived from MSVPA and "decay function (Fig. 2). C; body-weight of plaice (g) by age and quarter (MSVPA output). D; biomass of plaice (tonnes) by age and quarter (Column B * Column C). E; Sparholt (1990) total quarterly plaice biomass partitioned by age using MSVPA derived proportions of biomass at age

	A	B				C				D			
	Numbers	Numbers derived from MSVPA				Body-weight (MSVPA output)				Biomass derived from MSVPA			
		Quarter				Quarter				Quarter			
Age		1	2	3	4	1	2	3	4	1	2	3	4
0	837777	0	0	811729	724404	0	0	5	20	0	0	4059	14488
1	672254	646474	576927	514862	459473	150	150	150	150	96971	86539	77229	68921
2	658240	410044	365932	326565	291433	200	200	200	200	82009	73186	65313	58287
3	523961	260081	232102	207133	184850	252	252	252	252	65541	58490	52197	46582
4	232432	164964	147217	131380	117246	326	326	326	326	53778	47993	42830	38222
5	107028	104633	93376	83331	74366	422	422	422	422	44155	39405	35166	31383
6	48964	66366	59227	52855	47169	501	501	501	501	33249	29673	26480	23632
7	25097	42095	37566	33525	29918	604	604	604	604	25425	22690	20249	18071
8	13034	26700	23827	21264	18976	712	712	712	712	19010	16965	15140	13511
9	8797	16935	15113	13487	12036	782	782	782	782	13243	11818	10547	9412
10	6572	10741	9586	8555	7634	896	896	896	896	9624	8589	7665	6840
11	5005	6813	6080	5426	4842	973	973	973	973	6629	5916	5280	4712
12	3856	4321	3856	3442	3071	1049	1049	1049	1049	4533	4045	3610	3222
13	2809	2741	2446	2183	1948	1090	1090	1090	1090	2988	2666	2379	2123
14	2222	1739	1551	1385	1236	1172	1172	1172	1172	2038	1818	1623	1448
15	3762	1103	984	878	784	1580	1580	1580	1580	1742	1555	1388	1238

E				
Age partitioned Sparholt biomass				
Quarter				
	1	2	3	4
0	0	0	5194	20117
1	99930	99930	98837	85698
2-3	152051	152051	150389	145612
4-6	135185	135185	133707	129460
7+	87833	87833	86873	84113

Table 18

Tonnes of each prey species, and the total quantity of food, consumed daily in each quarter by plaice of different age

Age	0	1	2 & 3	4 - 6	7+	0	1	2 & 3	4 - 6	7+
	Quarter 1					**Quarter 2**				
Pectinaria koreni	0	1606	2968	231	0	0	246	598	543	0
Nephtys	0	0	22	95	0	0	227	529	114	0
Other polychaetes	0	722	322	855	0	0	181	57	37	0
Abra alba	0	118	317	388	0	0	5511	10162	2216	0
Cultellus pellucidus	0	84	150	42	0	0	123	80	20	0
Ensis ensis	0	157	234	184	0	0	13	11	44	0
Other Molluscs	0	112	397	98	0	0	175	57	379	0
Upogebia	0	0	0	0	984	0	0	0	0	1739
Total	0	2798	4409	1893	984	0	6475	11495	3353	1739
	Quarter 3					**Quarter 4**				
Pectinaria koreni	45	710	569	452	0	958	3794	2925	2344	0
Nephtys	2	30	42	20	0	20	80	59	101	0
Other polychaetes	8	128	70	171	0	25	100	373	1369	0
Abra alba	118	1866	2624	1287	0	231	916	248	72	0
Cultellus pellucidus	9	146	112	0	0	25	100	169	749	0
Ensis ensis	5	81	42	294	0	4	15	126	163	0
Other molluscs	2	24	31	22	0	0	0	31	5	0
Upogebia	0	0	0	0	1173	0	0	0	0	2498
Total	188	2985	3489	2246	1173	1263	5005	3932	4803	2498

Table 19

Diet (% by weight) of common dab by quarter (Knust, 1986)

	Q1	Q2	Q3	Q4
Hydroids	.0	9.0	.0	.0
Ophiuroids	66.0	70.0	9.0	62.0
Cumaceans	.0	.0	5.0	.0
Amphipods	2.0	2.0	23.0	2.0
Decapods	15.0	10.0	51.0	29.0
Polychaetes	17.0	7.0	10.0	7.0
Bivalves	.0	2.0	2.0	.0

Table 20

Diet (% by weight) of lemon sole by quarter (Rae, 1956)

Diet (%weight)	Q1	Q2	Q3	Q4
Polychaetes	57.8	57.8	57.8	57.8
Crustacea	4.8	4.8	4.8	4.8
Molluscs	10.7	10.7	10.7	10.7
Echinoderms	1.8	1.8	1.8	1.8
Coelenterates	21.0	21.0	21.0	21.0
Nemertea	.5	.5	.5	.5
Gephyrea	1.6	1.6	1.6	1.6
Ascidiae	1.2	1.2	1.2	1.2
Fish	.5	.5	.5	.5

Table 21

Converting annual average daily consumption rates (as % BW) for common dab and lemon sole to quarterly average daily rates taking into account seasonal variation in water temperature and feeding activity

I. Accounting for seasonal variation in temperature

Digestion model (after Gwyther and Grove, 1981): $DR = 0.034 \cdot e^{0.074T} \cdot w^{0.64}$
where DR = daily ration (g/day), T = water temperature and w = fish body weight (g)

Annual average daily ration (DRa) = 39.45 g/day taken by biomass of common dab of 4,000 g at annual average water temperature (Ta) of 7.75°C

	Temp T(Qx)	$e^{0.074T(Qx)}$	DRq(T) (g/day)	DRq(T) (%BW)
Q1	6	1.5589	34.658	.866
Q2	7	1.6787	37.320	.933
Q3	10	2.0959	46.597	1.165
Q4	8	1.8076	40.187	1.005
Ann ave	7.75	1.7745	39.690	.992

$DRq(T) = (e^{0.074T(Qx)} / e^{0.074Ta}) \cdot DRa$, where DRq(T) is the quarterly daily ration taking seasonal variation in water temperature into account

II. Accounting for seasonal variation in dab feeding activity

	%feeding	Qx/A.ave	Drq(TF) (g/day)	Drq(TF) (%BW)
Q1	55.00	.721	24.999	.625
Q2	70.00	.918	34.261	.857
Q3	90.00	1.180	55.000	1.375
Q4	90.00	1.180	47.433	1.186
Ann ave	76.25	1.000	40.423	1.011

III. Accounting for seasonal variation in lemon sole feeding activity

	%feeding	Qx/A.ave	Drq(TF) (g/day)	Drq(TF) (%BW)
Q1	52.70	.775	26.850	.671
Q2	94.70	1.392	51.955	1.299
Q3	90.70	1.333	62.129	1.553
Q4	34.00	.500	20.086	.502
Ann ave	68.025	1.000	40.255	1.006

DRq(TF) = Qx/A.ave . DRq(T) where DRq(TF) is the quarterly daily ration taking seasonal variation in water temperature and feeding activity into account

Table 22

Total quantity of food, and quantity of each prey type (tonnes/day), consumed daily by common dab

	Q1	Q2	Q3	Q4
Hydroids	0	1231	0	0
Ophiuroids	6449	9576	1979	11952
Cumaceans	0	0	1100	0
Amphipods	195	274	5058	386
Decapods	1466	1368	11216	5591
Polychaetes	1661	958	2199	1349
Bivalves	0	274	440	0
Total	9771	13680	21993	19278

Table 23

Total quantity of food, and quantity of each prey type (tonnes/day), consumed daily by lemon sole

	Q1	Q2	Q3	Q4
Polychaetes	877	1537	1646	470
Crustacea	72	126	135	39
Molluscs	162	284	305	87
Echinoderms	28	49	52	15
Coelenterates	318	558	598	171
Nemertea	8	14	15	4
Gephyrea	24	42	45	13
Ascidiae	19	33	36	10
Fish	8	14	15	4
Total	1516	2659	2847	813

Table 24

Diet (% by weight) and mean stomach contents weight (g) of mackerel by age and quarter (Daan, 1989)

Age	0	1&2	3-7	8+	0	1&2	3-7	8+	0	1&2	3-7	8+	0	1&2	3-7	8+
	Quarter 1				Quarter 2				Quarter 3				Quarter 4			
Cnidaria	.0	.4	.1	.1	.0	2.4	.4	.2	.6	.6	.3	.4	.0	.0	.1	.6
Annellida	.0	.0	.0	.0	.0	.6	.3	.1	.1	.1	.2	.0	.0	.0	.0	.0
Gastropoda	.0	.3	.0	.0	.0	.0	.0	.0	.8	.8	1.9	.8	2.3	2.3	2.0	3.0
Bivalvia	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cephalopoda	.0	.6	.8	.0	.0	.0	.2	.5	.1	.1	.3	.9	14.7	14.7	3.1	.0
Copepoda	.0	.0	.0	.0	.0	5.5	28.0	42.7	13.3	13.3	15.1	23.6	25.2	25.2	13.9	27.8
Amphipoda	.0	3.1	3.0	.0	.0	.0	.1	.5	.2	.2	.8	.5	.5	.5	.8	.1
Euphausiacea	.0	91.2	82.4	95.8	.0	.6	19.0	30.2	6.9	6.9	19.8	22.5	8.1	8.1	43.1	34.2
Crangonidae	.0	.0	.4	.0	.0	.0	.0	.0	.0	.0	.2	.2	.0	.0	.0	.0
Caridea	.0	.0	.4	.0	.0	.0	.0	.0	8.9	8.9	7.1	.2	.0	.0	.0	.0
Anomura	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Brachyura	.0	.0	.0	.0	.0	.0	.1	.0	4.8	4.8	3.8	5.6	3.8	3.8	.2	.0
Chaetognatha	.0	.0	.0	.0	.0	.0	.0	.0	6.8	6.8	3.2	.7	.0	.0	.0	.0
Urochordata	.0	.0	.0	.0	.0	1.7	1.8	1.3	17.6	17.6	5.2	1.4	19.6	19.6	6.0	.0
Cod	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	.0	.0	.0	.0	.0
Haddock	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.0	.0	.0	.0	.0
Whiting	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0
Norway pout	.0	1.6	.0	.0	.0	.2	.2	.3	5.8	5.8	6.5	7.9	11.7	11.7	9.1	24.2
Herring	.0	.0	.0	.0	.0	.0	.5	.6	2.5	2.5	5.0	11.3	.0	.0	7.2	2.1
Sprat	.0	1.6	.0	.0	.0	2.5	1.5	1.0	2.6	2.6	3.9	11.1	.0	.0	4.2	1.0
Sandeels	.0	.0	12.2	.0	.0	79.3	45.5	21.1	19.6	19.6	18.3	3.6	2.9	2.9	1.0	.0
Dab	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0
Mackerel	.0	.0	.0	.0	.0	.0	.2	.4	.0	.0	.0	.0	.0	.0	.0	.0
Unidentified prey	.0	1.2	.7	4.1	.0	7.1	2.2	1.1	9.3	9.3	7.7	9.3	11.2	11.2	9.3	7.0
Stomach weight (g)	.0	1.5	3.0	4.0	.0	2.6	5.7	8.6	.0	1.9	2.9	4.1	.0	1.5	2.7	4.3

Table 25

A; numbers of mackerel (x1000) at age ("0" group 1 July, "1+" 1 January; output from MSVPA). B; numbers of mackerel (x1000) by age and quarter derived from MSVPA and "decay function (Fig. 2). C; body-weight of mackerel (g) by age and quarter (MSVPA output). D; biomass of mackerel (tonnes) by age and quarter (Column B * Column C). E; Sparholt (1990) total quarterly mackerel biomass partitioned by age using MSVPA derived proportions of biomass at age

	A	B				C				D				E				
	Numbers	Numbers derived from MSVPA				Body-weight (MSVPA output)				Biomass derived from MSVPA				Age partitioned Sparholt biomass				
		Quarter				Quarter				Quarter				Quarter				
Age		1	2	3	4	1	2	3	4	1	2	3	4		1	2	3	4
0	95304	0	0	64757	61774	0	0	10	35	0	0	648	2162	0	0	0	2723	13123
1	70476	58929	56215	53626	51157	80	180	220	230	4714	10119	11798	11766	1-2	23184	65687	111230	151123
2	57927	48801	46553	44409	42364	215	275	330	310	10492	12802	14655	13133	3-7	73816	160144	244758	323734
3	54755	40413	38552	36776	35082	270	340	385	365	10911	13108	14159	12805	8+	59000	118169	173290	232020
4	39859	33467	31925	30455	29053	315	385	425	405	10542	12291	12943	11766					
5	23618	27714	26438	25221	24059	355	425	460	445	9839	11236	11601	10706					
6	12991	22951	21894	20886	19924	390	465	495	480	8951	10181	10338	9563					
7	11510	19006	18131	17296	16499	430	500	530	515	8173	9065	9167	8497					
8	10673	15739	15015	14323	13663	460	535	560	550	7240	8033	8021	7515					
9	10264	13034	12434	11861	11315	495	565	590	580	6452	7025	6998	6563					
10	9602	10794	10297	9822	9370	530	595	620	605	5721	6127	6090	5669					
11	7308	8939	8527	8134	7760	560	625	650	635	5006	5329	5287	4927					
12	7572	7402	7061	6736	6426	590	650	680	660	4367	4590	4581	4241					
13	6270	6130	5848	5578	5321	620	670	705	680	3801	3918	3933	3619					
14	6576	5076	4843	4620	4407	645	695	735	700	3274	3366	3395	3085					
15	8108	4204	4010	3826	3649	675	710	760	715	2838	2847	2907	2609					

Table 26

Daily food consumption of mackerel by age and quarter. Daily ration (g) is calculated using Mehl and Westgård's digestion model and this is converted to daily ration (%BW) using mackerel weight at age, by quarter, data. Knowing total biomass at age, by quarter, total daily food consumption (tonnes/day) can be determined

Age	0	1&2	3-7	8+	0	1&2	3-7	8+
	Quarter 1				**Quarter 2**			
Daily ration (g)	.0	.6	1.2	1.6	.0	1.2	2.8	4.2
Daily ration (%BW)	.00	.35	.35	.29	.00	.53	.67	.69
Consumption (t/d)	0	81	256	174	0	351	1067	819
	Quarter 3				**Quarter 4**			
Daily ration (g)	.0	1.7	2.6	3.6	.0	.9	1.6	2.6
Daily ration (%BW)	.00	.59	.57	.57	.00	.33	.37	.41
Consumption (t/d)	17	656	1395	992	46	498	1209	960

Table 27

Total daily consumption (tonnes/day) of prey by mackerel, by age and quarter

Age	0	1&2	3-7	8+	0	1&2	3-7	8+	0	1&2	3-7	8+	0	1&2	3-7	8+
	Quarter 1				**Quarter 2**				**Quarter 3**				**Quarter 4**			
Cnidaria	.0	.3	.3	.2	.0	8.4	4.3	1.6	.1	3.9	4.2	4.0	.0	.0	1.2	5.8
Annellida	.0	.0	.0	.0	.0	2.1	3.2	.8	.0	.7	2.8	.0	.0	.0	.0	.0
Gastropoda	.0	.2	.0	.0	.0	.0	.0	.0	.1	5.3	26.5	7.9	1.1	11.5	24.2	28.8
Bivalvia	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cephalopoda	.0	.5	2.0	.0	.0	.0	2.1	4.1	.0	.7	4.2	8.9	6.8	73.2	37.5	.0
Copepoda	.0	.0	.0	.0	.0	19.3	298.7	349.6	2.3	87.3	210.6	234.1	11.6	125.6	168.1	267.0
Amphipoda	.0	2.5	7.7	.0	.0	.0	1.1	4.1	.0	1.3	11.2	5.0	.2	2.5	9.7	1.0
Euphausiacea	.0	74.0	210.7	166.4	.0	2.1	202.7	247.3	1.2	45.3	276.2	223.2	3.7	40.4	521.2	328.4
Crangonidae	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	2.8	2.0	.0	.0	.0	.0
Caridea	.0	.0	1.0	.0	.0	.0	.0	.0	1.5	58.4	99.0	2.0	.0	.0	.0	.0
Anomura	.0	.0	.0	.0	.0	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Brachyura	.0	.0	.0	.0	.0	.0	1.1	.0	.8	31.5	53.0	55.6	1.7	18.9	2.4	.0
Chaetognatha	.0	.0	.0	.0	.0	.0	.0	.0	1.2	44.6	44.6	6.9	.0	.0	.0	.0
Urochordata	.0	.0	.0	.0	.0	6.0	19.2	10.6	3.0	115.5	72.5	13.9	9.0	97.7	72.6	.0
Cod	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	5.6	.0	.0	.0	.0	.0
Haddock	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2.8	.0	.0	.0	.0	.0
Whiting	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.4	.0	.0	.0	.0	.0
Norway pout	.0	1.3	.0	.0	.0	.7	2.1	2.5	1.0	38.1	90.7	78.4	5.4	58.3	110.0	232.4
Herring	.0	.0	.0	.0	.0	.0	5.3	4.9	.4	16.4	69.7	112.1	.0	.0	87.1	20.2
Sprat	.0	1.3	.0	.0	.0	8.8	16.0	8.2	.4	17.1	54.4	110.1	.0	.0	50.8	9.6
Sandeels	.0	.0	31.2	.0	.0	278.4	485.3	172.8	3.4	128.7	255.3	35.7	1.3	14.5	12.1	.0
Dab	.0	.0	.0	.0	.0	.0	.0	.0	.0	.7	.0	.0	.0	.0	.0	.0
Mackerel	.0	.0	.0	.0	.0	.0	2.1	3.3	.0	.0	.0	.0	.0	.0	.0	.0
Unidentified prey	.0	1.0	1.8	7.1	.0	24.9	23.5	9.0	1.6	61.1	107.4	92.3	5.1	55.8	112.5	67.2

Table 28

Diet (% by weight) of horse mackerel, by length class (Dahl and Kirkegaard, 1987)

Length class (cms)	20-24	25-29	30-34	35-39
Copepoda	54.5	16.5	.0	.0
Decapoda	38.7	35.1	10.3	.1
Crangon crangon	.0	.0	.0	.0
Other Caridea	.0	.3	2.7	.0
Cod	.0	2.7	12.3	.0
Haddock	.0	7.7	2.6	.0
Whiting	.0	22.5	35.4	50.2
Herring	.0	8.2	10.4	17.7
Sprat	.0	.0	.8	.0
Ammodytidae	.0	.0	.0	.0
Gadidae	.0	6.6	22.5	32.1
Clupeidae	.0	.0	1.6	.0
Pipe fish	.0	.0	.0	.0
Unidentified gurnards	.0	.0	1.4	.0
Crystal goby	6.8	.1	.0	.0
Flatfish larvae	.0	.3	.0	.0

Table 29

Numbers of horse mackerel at length in the Danish study area and the quantity of food consumed daily (Dahl and Kirkegaard, 1987). Numbers converted to weight at length (Coull *et al.*, 1989) and consumption also given as a percentage of predator weight

Length (cm)	Number at length (million)	Weight at length (tonnes)	Consump at length (tonnes)	Consump at length (% BW)
20	6.1	400.7	14.6	3.6
21				
22	12.4	1114.9	24.2	2.2
23	50.0	5204.6	89.1	1.7
24	370.8	44406.7	602.9	1.4
25	563.8	77239.2	893.5	1.2
26	523.1	81547.4	923.2	1.1
27	265.9	46939.5	870.6	1.9
28	102.2	20337.7	400.5	2.0
29	118.7	26516.0	575.6	2.2
30	241.0	60197.2	1368.9	2.3
31	197.4	54931.2	1547.9	2.8
32	105.7	32656.5	1140.8	3.5
33	46.2	15796.5	509.4	3.2
34	20.1	7582.7	290.6	3.8
35	6.9	2863.9	112.5	3.9
36	.1	45.5	2.4	5.3
37	1.6	797.5	33.5	4.2

Table 30

Total quantity of food consumed daily, and quantity of each prey type, by the biomass of horse mackerel belonging to each length group in the Danish study. Consumption by the whole predator population is also shown. The daily consumption of each prey type as a percentage of the total predator population biomass is determined. These data are for quarter 3

Length class	20-24	25-29	30-34	35-39	All fish	Prey consumption as a % of total predator biomass
Horse mackerel biomass	51127	252580	171164	3707	478578	
Consumption % biomass	1.43	1.45	2.84	4.00	1.96	
Tonnes prey consumed	730.8	3663.4	4857.6	148.4	9400.2	
Copepoda	398.5	602.9	.0	.	1001.4	.209
Decapoda	282.6	1284.7	502.6	.1	2069.9	.433
Crangon crangon	.0	.0	.0	.0	.0	.000
Other Caridea	.0	11.8	129.4	.0	141.2	.030
Cod	.0	99.5	596.0	.0	695.5	.145
Haddock	.0	283.5	123.9	.0	407.4	.085
Whiting	.0	823.3	1721.6	74.5	2619.4	.547
Herring	.0	298.6	506.0	26.3	830.8	.174
Sprat	.0	.0	39.5	.0	39.5	.008
Ammodytidae	.0	.0	.0	.0	.0	.000
Gadidae	.0	240.7	1090.6	47.6	1378.8	.288
Clupeidae	.0	.0	79.0	.0	79.0	.016
Pipe fish	.0	1.8	.0	.0	1.8	.000
Unidentified gurnards	.0	.0	69.1	.0	69.1	.014
Crystal goby	49.7	4.2	.0	.0	53.9	.011
Flatfish larvae	.0	12.5	.0	.0	12.5	.003

Table 31

Determination of seasonal variation in mackerel daily food consumption rates (as a percentage of predator population biomass expressed for each quarter as a ratio of the quarter three value

	Q1	Q2	Q3	Q4
Biomass (tonnes)	156000	344000	532000	720000
Total Consumption (tonnes/d)	510.5	2236.5	3060.5	2713.8
Consumption as % biomass	.327	.650	.575	.377
Ratio Qx:Q3 Consumption as % biomass	.569	1.130	1.000	.655

Table 32

The daily consumption of each prey type taken by horse mackerel expressed as a percentage of the total horse mackerel biomass

	Q1	Q2	Q3	Q4
Copepoda	.119	.236	.209	.137
Decapoda	.246	.489	.433	.283
Crangon crangon	.000	.000	.000	.000
Other Caridea	.017	.033	.030	.019
Cod	.083	.164	.145	.095
Haddock	.048	.096	.085	.056
Whiting	.311	.619	.547	.359
Herring	.099	.196	.174	.114
Sprat	.005	.009	.008	.005
Ammodytidae	.000	.000	.000	.000
Gadidae	.164	.326	.288	.189
Clupeidae	.009	.019	.016	.011
Pipe fish	.000	.000	.000	.000
Unidentified gurnards	.008	.016	.014	.009
Crystal goby	.006	.013	.011	.007
Flatfish larvae	.001	.003	.003	.002

Table 33

The daily consumption (tonnes) of each prey type taken by horse mackerel in each quarter

	Q1	Q2	Q3	Q4
Copepoda	7	927	1922	2172
Decapoda	15	1917	3972	4491
Crangon crangon	0	0	0	0
Other Caridea	1	131	271	306
Cod	5	644	1335	1509
Haddock	3	377	782	884
Whiting	19	2426	5027	5683
Herring	6	769	1594	1802
Sprat	0	37	76	86
Ammodytidae	0	0	0	0
Gadidae	10	1277	2646	2991
Clupeidae	1	73	152	171
Pipe fish	0	2	3	4
Unidentified gurnards	0	64	133	150
Crystal goby	0	50	103	117
Flatfish larvae	0	12	24	27

Table 34

Diet (% by dry weight) of Norway pout by age and quarter (Albert, 1991)

Age	0	1	2	3+	0	1	2	3+	0	1	2	3+	0	1	2	3+
	Quarter 1				Quarter 2				Quarter 3				Quarter 4			
Polychaeta	.0	.0	.0	.0	.0	.1	.2	.2	.1	.1	.2	.2	.0	.0	.0	.0
Ostracoda	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Calanoida	.0	11.4	2.9	2.9	.0	38.8	13.9	13.9	38.8	38.8	13.9	13.9	11.4	11.4	2.9	2.9
Paraeuchaeta norvegica	.0	2.0	4.1	4.1	.0	4.5	1.7	1.7	4.5	4.5	1.7	1.7	2.0	2.0	4.1	4.1
Mysidae	.0	.6	.3	.3	.0	2.8	3.2	3.2	2.8	2.8	3.2	3.2	.6	.6	.3	.3
Amblyops abreviata	.0	.1	.0	.0	.0	.4	.3	.3	.4	.4	.3	.3	.1	.1	.0	.0
Boreomysis arctica	.0	.0	.0	.0	.0	.1	.2	.2	.1	.1	.2	.2	.0	.0	.0	.0
Boreomysis nobilis	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
Pseudomma roseum	.0	.0	.0	.0	.0	.2	.2	.2	.2	.2	.2	.2	.0	.0	.0	.0
Pseudomma affine	.0	.0	.0	.0	.0	.1	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0
Erythrops serrata	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Lampropidae	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Flabellifera	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.1	.1	.0	.0	.0	.0
Gammaridae	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0
Hyperiidae	.0	.2	.1	.1	.0	.1	.4	.4	.1	.1	.4	.4	.2	.2	.1	.1
Parathemisto abyssorum	.0	.3	.3	.3	.0	1.3	9.1	9.1	1.3	1.3	9.1	9.1	.3	.3	.3	.3
Caprellidae	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Euphausiidae	.0	29.5	19.1	19.1	.0	29.8	29.5	29.5	29.8	29.8	29.5	29.5	29.5	29.5	19.1	19.1
Meganyctiphanes norvegic	.0	42.8	59.1	59.1	.0	15.8	30.1	30.1	15.8	15.8	30.1	30.1	42.8	42.8	59.1	59.1
Thysanoessa raschii	.0	6.3	3.2	3.2	.0	.4	.3	.3	.4	.4	.3	.3	6.3	6.3	3.2	3.2
Pasiphaeidae	.0	.0	8.6	8.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	8.6	8.6
Pasiphaea tarda	.0	1.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	1.0	1.0	.1	.1
Pandalidae	.0	.0	.0	.0	.0	2.7	.0	.0	2.7	2.7	.0	.0	.0	.0	.0	.0
Pandalus borealis	.0	.0	.0	.0	.0	1.1	5.6	5.6	1.1	1.1	5.6	5.6	.0	.0	.0	.0
Crangonidae	.0	.0	.0	.0	.0	.2	3.4	3.4	.2	.2	3.4	3.4	.0	.0	.0	.0
Pontophilus norvegicus	.0	.0	.0	.0	.0	.2	.2	.2	.2	.2	.2	.2	.0	.0	.0	.0
Galatheidae	.0	.0	.0	.0	.0	.0	.3	.3	.0	.0	.3	.3	.0	.0	.0	.0
Munida sarsi	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.1	.1	.0	.0	.0	.0
Echinodermata	.0	.1	.8	.8	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.8	.8
Chaetognatha	.0	5.7	1.3	1.3	.0	1.3	.8	.8	1.3	1.3	.8	.8	5.7	5.7	1.3	1.3
Teleostei	.0	.0	.0	.0	.0	.0	.3	.3	.0	.0	.3	.3	.0	.0	.0	.0

Table 35

Incidence of full and empty Norway pout stomachs, mean dry weight of the contents of full stomachs, and total dry weight of food material examined, by age and quarter (Albert, 1991)

	1	2	3+	1	2	3+
	Quarter 1			**Quarter 2**		
Number full stomachs	184	142	142	226	192	192
Number empty stomachs	93	46	46	87	44	44
Total number stomachs	277	188	188	313	236	236
% Empty stomachs	33.6	24.5	24.5	27.8	18.6	18.6
Mn dry weight (mg) stomach contents	16.9	57.8	57.8	23.5	31.2	31.2
Tot dry weight (mg) food	3109.6	8207.6	8207.6	5311.0	5990.4	5990.4
	Quarter 3			**Quarter 4**		
Number full stomachs	226	192	192	184	142	142
Number empty stomachs	87	44	44	93	46	46
Total number stomachs	313	236	236	277	188	188
% Empty stomachs	27.8	18.6	18.6	33.6	24.5	24.5
Mn dry weight (mg) stomach contents	23.5	31.2	31.2	16.9	57.8	57.8
Tot dry weight (mg) food	5311.0	5990.4	5990.4	3109.6	8207.6	8207.6

Table 36

Dry weight (mg) of material examined in samples of Norway pout stomachs, by age and quarter

Age	1	2	3+	1	2	3+	1	2	3+	1	2	3+
	Quarter 1			Quarter 2			Quarter 3			Quarter 4		
Polychaeta	0	0	0	5	12	12	5	12	12	0	0	0
Ostracoda	0	0	0	0	0	0	0	0	0	0	0	0
Calanoida	354	238	238	2061	833	833	2061	833	833	354	238	238
Paraeuchaeta norvegica	62	337	337	239	102	102	239	102	102	62	337	337
Mysidae	19	25	25	149	192	192	149	192	192	19	25	25
Amblyops abreviata	3	0	0	21	18	18	21	18	18	3	0	0
Boreomysis arctica	0	0	0	5	12	12	5	12	12	0	0	0
Boreomysis nobilis	0	8	8	0	0	0	0	0	0	0	8	8
Pseudomma roseum	0	0	0	11	12	12	11	12	12	0	0	0
Pseudomma affine	0	0	0	5	0	0	5	0	0	0	0	0
Erythrops serrata	0	0	0	0	0	0	0	0	0	0	0	0
Lampropidae	0	0	0	0	0	0	0	0	0	0	0	0
Flabellifera	0	0	0	0	6	6	0	6	6	0	0	0
Gammaridae	0	0	0	5	6	6	5	6	6	0	0	0
Hyperiidae	6	8	8	5	24	24	5	24	24	6	8	8
Parathemisto abyssorum	9	25	25	69	545	545	69	545	545	9	25	25
Caprellidae	0	0	0	0	0	0	0	0	0	0	0	0
Euphausiidae	917	1568	1568	1583	1767	1767	1583	1767	1767	917	1568	1568
Meganyctiphanes norvegica	1331	4851	4851	839	1803	1803	839	1803	1803	1331	4851	4851
Thysanoessa raschii	196	263	263	21	18	18	21	18	18	196	263	263
Pasiphaeidae	0	706	706	0	0	0	0	0	0	0	706	706
Pasiphaea tarda	31	8	8	0	0	0	0	0	0	31	8	8
Pandalidae	0	0	0	143	0	0	143	0	0	0	0	0
Pandalus borealis	0	0	0	58	335	335	58	335	335	0	0	0
Crangonidae	0	0	0	11	204	204	11	204	204	0	0	0
Pontophilus norvegicus	0	0	0	11	12	12	11	12	12	0	0	0
Galatheidae	0	0	0	0	18	18	0	18	18	0	0	0
Munida sarsi	0	0	0	0	6	6	0	6	6	0	0	0
Echinodermata	3	66	66	0	0	0	0	0	0	3	66	66
Chaetognatha	177	107	107	69	48	48	69	48	48	177	107	107
Teleostei	0	0	0	0	18	18	0	18	18	0	0	0

Table 37

Proportion contribution of water to the wet weight of prey in the diet of Norway pout

Prey species	Water
Polychaeta	.85
Ostracoda	.51
Calanoida	.87
Paraeuchaeta norvegica	.72
Mysidae	.81
Amblyops abreviata	.78
Boreomysis arctica	.75
Boreomysis nobilis	.75
Pseudomma roseum	.77
Pseudomma affine	.77
Erythrops serrata	.78
Lampropidae	.76
Flabellifera	.79
Gammaridae	.81
Hyperiidae	.79
Parathemisto abyssorum	.79
Caprellidae	.78
Euphausiidae	.75
Meganyctiphanes norvegica	.76
Thysanoessa raschii	.74
Pasiphaeidae	.78
Pasiphaea tarda	.78
Pandalidae	.79
Pandalus borealis	.79
Crangonidae	.81
Pontophilus norvegicus	.83
Galatheidae	.6
Munida sarsi	.6
Echinodermata	.46
Chaetognatha	.91
Teleostei	.76

Table 38

Wet weight (g) of material examined in samples of Norway pout stomachs, by age and quarter

Age	1	2	3+	1	2	3+	1	2	3+	1	2	3+
	Quarter 1			Quarter 2			Quarter 3			Quarter 4		
Polychaeta	.0	.0	.0	.0	.1	.1	.0	.1	.1	.0	.0	.0
Ostracoda	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Calanoida	2.7	1.8	1.8	15.9	6.4	6.4	15.9	6.4	6.4	2.7	1.8	1.8
Paraeuchaeta norvegica	.2	1.2	1.2	.9	.4	.4	.9	.4	.4	.2	1.2	1.2
Mysidae	.1	.1	.1	.8	1.0	1.0	.8	1.0	1.0	.1	.1	.1
Amblyops abreviata	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0
Boreomysis arctica	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Boreomysis nobilis	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Pseudomma roseum	.0	.0	.0	.0	.1	.1	.0	.1	.1	.0	.0	.0
Pseudomma affine	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Erythrops serrata	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Lampropidae	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Flabellifera	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Gammaridae	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Hyperiidae	.0	.0	.0	.0	.1	.1	.0	.1	.1	.0	.0	.0
Parathemisto abyssorum	.0	.1	.1	.3	2.6	2.6	.3	2.6	2.6	.0	.1	.1
Caprellidae	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Euphausiidae	3.7	6.3	6.3	6.3	7.1	7.1	6.3	7.1	7.1	3.7	6.3	6.3
Meganyctiphanes norvegica	5.5	20.2	20.2	3.5	7.5	7.5	3.5	7.5	7.5	5.5	20.2	20.2
Thysanoessa raschii	.8	1.0	1.0	.1	.1	.1	.1	.1	.1	.8	1.0	1.0
Pasiphaeidae	.0	3.2	3.2	.0	.0	.0	.0	.0	.0	.0	3.2	3.2
Pasiphaea tarda	.1	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0
Pandalidae	.0	.0	.0	.7	.0	.0	.7	.0	.0	.0	.0	.0
Pandalus borealis	.0	.0	.0	.3	1.6	1.6	.3	1.6	1.6	.0	.0	.0
Crangonidae	.0	.0	.0	.1	1.1	1.1	.1	1.1	1.1	.0	.0	.0
Pontophilus norvegicus	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0
Galatheidae	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Munida sarsi	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Echinodermata	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.1	.1
Chaetognatha	2.0	1.2	1.2	.8	.5	.5	.8	.5	.5	2.0	1.2	1.2
Teleostei	.0	.0	.0	.0	.1	.1	.0	.1	.1	.0	.0	.0
Unknown prey	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Tot wet weight (g) food	15.2	35.4	35.4	29.8	28.9	28.9	29.8	28.9	28.9	15.2	35.4	35.4
Mean wet wt (g) full stomachs	.083	.249	.249	.132	.150	.150	.132	.150	.150	.083	.249	.249
Mean wet wt (g) all stomachs	.055	.188	.188	.095	.122	.122	.095	.122	.122	.055	.188	.188

Table 39

Diet (% by wet weight) of Norway pout by age and quarter

Age	1	2	3+	1	2	3+	0	1	2	3+	0	1	2	3+
	Quarter 1			Quarter 2			Quarter 3				Quarter 4			
Polychaeta	.0	.0	.0	.1	.3	.3	.1	.1	.3	.3	.0	.0	.0	.0
Ostracoda	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Calanoida	17.9	5.2	5.2	53.1	22.2	22.2	53.1	53.1	22.2	22.2	17.9	17.9	5.2	5.2
Paraeuchaeta norvegica	1.5	3.4	3.4	2.9	1.3	1.3	2.9	2.9	1.3	1.3	1.5	1.5	3.4	3.4
Mysidae	.6	.4	.4	2.6	3.5	3.5	2.6	2.6	3.5	3.5	.6	.6	.4	.4
Amblyops abreviata	.1	.0	.0	.3	.3	.3	.3	.3	.3	.3	.1	.1	.0	.0
Boreomysis arctica	.0	.0	.0	.1	.2	.2	.1	.1	.2	.2	.0	.0	.0	.0
Boreomysis nobilis	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
Pseudomma roseum	.0	.0	.0	.2	.2	.2	.2	.2	.2	.2	.0	.0	.0	.0
Pseudomma affine	.0	.0	.0	.1	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0
Erythrops serrata	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Lampropidae	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Flabellifera	.0	.0	.0	.0	.1	.1	.0	.0	.1	.1	.0	.0	.0	.0
Gammaridae	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0
Hyperiidae	.2	.1	.1	.1	.4	.4	.1	.1	.4	.4	.2	.2	.1	.1
Parathemisto abyssorum	.3	.3	.3	1.1	9.0	9.0	1.1	1.1	9.0	9.0	.3	.3	.3	.3
Caprellidae	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Euphausiidae	24.1	17.7	17.7	21.2	24.5	24.5	21.2	21.2	24.5	24.5	24.1	24.1	17.7	17.7
Meganyctiphanes norvegica	36.4	57.1	57.1	11.7	26.0	26.0	11.7	11.7	26.0	26.0	36.4	36.4	57.1	57.1
Thysanoessa raschii	5.0	2.9	2.9	.3	.2	.2	.3	.3	.2	.2	5.0	5.0	2.9	2.9
Pasiphaeidae	.0	9.1	9.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	9.1	9.1
Pasiphaea tarda	.9	.1	.1	.0	.0	.0	.0	.0	.0	.0	.9	.9	.1	.1
Pandalidae	.0	.0	.0	2.3	.0	.0	2.3	2.3	.0	.0	.0	.0	.0	.0
Pandalus borealis	.0	.0	.0	.9	5.5	5.5	.9	.9	5.5	5.5	.0	.0	.0	.0
Crangonidae	.0	.0	.0	.2	3.7	3.7	.2	.2	3.7	3.7	.0	.0	.0	.0
Pontophilus norvegicus	.0	.0	.0	.2	.2	.2	.2	.2	.2	.2	.0	.0	.0	.0
Galatheidae	.0	.0	.0	.0	.2	.2	.0	.0	.2	.2	.0	.0	.0	.0
Munida sarsi	.0	.0	.0	.0	.1	.1	.0	.0	.1	.1	.0	.0	.0	.0
Echinodermata	.0	.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	.3
Chaetognatha	12.9	3.3	3.3	2.6	1.8	1.8	2.6	2.6	1.8	1.8	12.9	12.9	3.3	3.3
Teleostei	.0	.0	.0	.0	.3	.3	.0	.0	.3	.3	.0	.0	.0	.0

Table 40

A; numbers of Norway pout (x1000) at age ("0" group 1 July, "1+" 1 January; output from MSVPA). B; numbers of Norway pout (x1000) by age and quarter derived from MSVPA and "decay function (Fig. 2). C; body-weight of Norway pout (g) by age and quarter (MSVPA output). D; biomass of Norway pout (tonnes) by age and quarter (Column B * Column C). E; Sparholt (1990) total quarterly Norway pout biomass partitioned by age using MSVPA derived proportions of biomass at age

	A	B				C				D				E			
	Numbers	Numbers derived from MSVPA				Body-weight (MSVPA output)				Biomass derived from MSVPA				Age partitioned Sparholt biomass			
		Quarter				Quarter				Quarter				Quarter			
Age		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
0	2.517e8	0	0	3.123e8	1.632e8	.0	1.2	4.9	6.9	0	0	1530178	1126015	0	0	884519	1094691
1	1.088e8	8.52e7	4.456e7	2.329e7	1.217e7	7.6	11.2	26.1	26.1	648123	499127	607830	317637	749838	933925	351356	308801
2	6700346	6359748	3323448	1736752	907584	23.8	25.9	40.0	44.0	151362	86077	69470	39934	175116	161061	40157	38823
3+	437808	474281	247848	129519	67684	42.0	31.0	53.0	56.0	19920	10162	6865	3790	23046	19014	3968	3685

Table 41

Estimation of Norway pout daily food ration (g) by age and quarter. Ration also expressed as a percentage of fish body weight

Age	0	1	2	3+	0	1	2	3+
	Quarter 1				**Quarter 2**			
Stomach contents weight (g)	.000	.055	.188	.188	.000	.095	.122	.122
Mean fish len (cm)	.0	10.3	14.8	17.8	5.8	11.9	15.5	18.0
Mean fish wght (g)	.0	7.6	23.8	42.0	1.2	11.2	25.9	41.0
Daily ration (g)	.000	.117	.342	.440	.000	.199	.324	.397
Daily ration (%BW)	.000	1.537	1.437	1.048	2.000	1.778	1.251	.969
	Quarter 3				**Quarter 4**			
Stomach contents weight (g)	.000	.095	.122	.122	.000	.055	.188	.188
Mean fish len (cm)	8.8	15.0	17.1	18.7	9.7	14.8	17.4	18.8
Mean fish wght (g)	4.9	26.1	40.0	53.0	6.9	26.1	44.0	56.0
Daily ration (g)	.000	.350	.474	.537	.000	.227	.504	.561
Daily ration (%BW)	1.700	1.340	1.186	1.014	1.300	.869	1.145	1.002

Table 42

Consumption (tonnes/day) of each prey type by Norway pout, by age and quarter

	Quarter 1			Quarter 2			Quarter 3				Quarter 4			
Age	1	2	3+	1	2	3+	0	1	2	3+	0	1	2	3+
Polychaeta	0	0	0	20	6	1	18	6	1	0	0	0	0	0
Ostracoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calanoida	2065	130	12	8816	447	41	7986	2501	106	9	1961	481	23	2
Paraeuchaeta norvegica	168	85	8	475	25	2	430	135	6	1	160	39	15	1
Mysidae	74	9	1	435	70	6	394	123	17	1	71	17	2	0
Amblyops abreviata	11	0	0	54	6	1	49	15	1	0	10	2	0	0
Boreomysis arctica	0	0	0	12	3	0	11	3	1	0	0	0	0	0
Boreomysis nobilis	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Pseudomma roseum	0	0	0	26	4	0	23	7	1	0	0	0	0	0
Pseudomma affine	0	0	0	13	0	0	12	4	0	0	0	0	0	0
Erythrops serrata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lampropidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Flabellifera	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Gammaridae	0	0	0	16	2	0	14	4	1	0	0	0	0	0
Hyperiidae	22	3	0	14	8	1	13	4	2	0	21	5	0	0
Parathemisto abyssorum	34	8	1	183	181	17	166	52	43	4	32	8	1	0
Caprellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euphausiidae	2779	446	43	3521	493	45	3189	999	117	10	2639	647	79	7
Meganyctiphanes norvegica	4200	1437	138	1945	524	48	1761	552	124	10	3989	977	254	21
Thysanoessa raschii	571	72	7	45	5	0	41	13	1	0	542	133	13	1
Pasiphaeidae	0	228	22	0	0	0	0	0	0	0	0	0	40	3
Pasiphaea tarda	107	3	0	0	0	0	0	0	0	0	102	25	0	0
Pandalidae	0	0	0	380	0	0	344	108	0	0	0	0	0	0
Pandalus borealis	0	0	0	155	112	10	140	44	26	2	0	0	0	0
Crangonidae	0	0	0	31	75	7	28	9	18	1	0	0	0	0
Pontophilus norvegicus	0	0	0	35	5	0	31	10	1	0	0	0	0	0
Galatheidae	0	0	0	0	3	0	0	0	1	0	0	0	0	0
Munida sarsi	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Echinodermata	4	9	1	0	0	0	0	0	0	0	4	1	2	0
Chaetognatha	1492	84	8	427	37	3	386	121	9	1	1416	347	15	1
Teleostei	0	0	0	0	5	0	0	0	1	0	0	0	0	0

Table 43

Herring diet (numbers of items) at length in February and August (Last, 1989)

Length	Number						Total	%No	%Wt	Relative biomass 1 item
	5-9	10-14	15-19	20-24	25-29	30-34				
February 1983										
Paracalanus parvus			113				113	1.52		.00010
Calanus finmarchius			1719	16			1735	23.38	2.8	.00161
Temora longicaudata			21				21	.28		.00017
Hyperiidea			746	606	26		1378	18.57	4.1	.00298
Euphausiacea			1833	553	643		3029	40.82	91.2	.03011
Plaice eggs			1080	32			1112	14.98	1.8	.00162
Sagitta setosa			26				26	.35		.00042
Unidentified prey			7				7	.09		.00000
Number of prey			5545	1207	669		7421	100.0	99.9	
Number of fish			1028	446	164	15	1653			
% fish feeding			39.0	13.0	14.0	0				
Number prey/fish			5.4	2.7	4.1					
February 1984										
Paracalanus parvus	12	111	272	39	1124		1558	2.63		.00009
Calanus finmarchius	42	2703	922	444	193	1	4305	7.27	6.4	.00149
Temora longicaudata	3	2450	5297	1266	25828	11190	46034	77.71	6.8	.00015
Hyperiidea		1121	537	1069	940	367	4034	6.81	11.2	.00278
Mysidacea		99	150	15	11	2	277	.47	9.7	.03502
Euphausiacea		272	439	229	239	298	1477	2.49	40.9	.02769
Sagitta setosa		247	87	79	40		453	.76		.00039
Plaice eggs		255	85	147	102	1	590	1.00		.00149
Other fish eggs		25	6	93	198	1	323	.55		.00054
Clupeoid post-larvae		1	14	4	14	17	50	.08	27.7	.55400
Unidentified prey		24	9	17	71	16	137	.23		.00000
Number of prey	57	7308	7818	3402	28760	11893	59238	100.0	102.7	
Number of fish	10	207	244	150	25	28	764			
% fish feeding	70.0	56.5	50.4	26.7	55.2	78.6				
Number prey/fish	5.7	35.3	32.0	22.7	228.6	424.7				
February 1986										
Paracalanus parvus	315	1346	1446				3107	6.09		.00002
Pseudocalanus elongatus		53	12	1			66	.13		.00002
Calanus finmarchius	392	16251	7310	1773	10		25736	50.44	9.1	.00035
Centropages typicus		2	3	13			18	.04		.00047
Temora longicaudata	925	2302	941	34	143		4345	8.52		.00038
Euchaeta norvegica		60	120				180	.35		.00071
Gammaridea	1	13	5				19	.04		.00130
Hyperiidea	1	1214	4111	3646	1250	48	10270	20.13	13.9	.00135
Mysidacea	43	493	183	30	35		784	1.54	5.4	.00689
Euphausiacea		1240	1448	715	938	234	4575	8.97	61	.01333
Crangon vulgaris		1	5	36		1	43	.08		.00700
Sagitta setosa	1	434	482	216			1133	2.22		.00009
Plaice eggs		188	428	5	4		625	1.23		.00035
Other fish eggs		3	1				4	.01		.00013
Clupeoid post-larvae		20	40	8	4	1	73	.14	6.5	.08904
Goby post-larvae		1	2	4	4		11	.02		.05000
Other fish post-larvae		3	2	3	4		12	.02		.05000
Unidentified prey	5	7	7				19	.04		.00000
Number of prey	1683	23631	6546	6484	2392	284	51020	100.0	95.9	
Number of fish	36	1106	914	320	216	27	2619			
% fish feeding	69.4	48.9	45.6	43.4	42.1	37.0				
Number prey/fish	46.8	21.4	18.1	20.3	11.1	10.5				

Length	Number						Total	%No	%Wt	Relative biomass 1 item
	5-9	10-14	15-19	20-24	25-29	30-34				
August/September 1986										
Calanus finmarchius		2638	4290	1784	3259	228	12199	48.04	2.6	.00021
Temora longicaudata		96	21	18	80		215	.85		.00002
Hyperiidea		54	5	136	109	56	360	1.42		.00008
Ostracods				1	8		9	.04		.00020
Mysidacea		73	130	88	26		317	1.25		.00042
Euphausiacea		221	839	3158	5916	1403	11537	45.43	93.5	.00810
Decapod zoea		1	104	2	103		210	.83		.00005
Sagitta setosa		221	170	36	89		516	2.03		.00006
Clupeoid post-larvae		1	9				10	.04		.07978
Norway pout post-larvae				2	7		9	.04		.08000
Other fish post-larvae				1		1	2	.01		.05000
Ammodytes				1	1		2	.01		.00531
Number of prey	0	3310	5569	5227	9600	1688	25394	100.0	96.1	
Number of fish	0	62	129	140	125	15	471			
% fish feeding	.0	72.5	72.1	67.9	61.6	86.7				
Number prey/fish	0	53.4	43.2	37.3	76.8	112.5				

Table 44

Herring diet (relative weight of items) at length in February and August

Length	5-9	10-14	15-19	20-24	25-29	30-34
February 1983						
Paracalanus parvus	.00	.00	.01	.00	.00	.00
Calanus finmarchius	.00	.00	2.77	.03	.00	.00
Temora longicaudata	.00	.00	.00	.00	.00	.00
Hyperiidea	.00	.00	2.22	1.80	.08	.00
Euphausiacea	.00	.00	55.19	16.65	19.36	.00
Plaice eggs	.00	.00	1.75	.05	.00	.00
Sagitta setosa	.00	.00	.01	.00	.00	.00
Total	.00	.00	61.96	18.53	19.44	.00
February 1984						
Paracalanus parvus	.00	.01	.03	.00	.10	.00
Calanus finmarchius	.06	4.02	1.37	.66	.29	.00
Temora longicaudata	.00	.36	.78	.19	3.82	1.65
Hyperiidea	.00	3.11	1.49	2.97	2.61	1.02
Mysidacea	.00	3.47	5.25	.53	.39	.07
Euphausiacea	.00	7.53	12.16	6.34	6.62	8.25
Sagitta setosa	.00	.10	.03	.03	.02	.00
Plaice eggs	.00	.38	.13	.22	.15	.00
Other fish eggs	.00	.01	.00	.05	.11	.00
Clupeoid post-larvae	.00	.55	7.76	2.22	7.76	9.42
Total	.06	19.55	29.00	13.20	21.85	20.42
February 1986						
Paracalanus parvus	.01	.03	.03	.00	.00	.00
Pseudocalanus elongatus	.00	.00	.00	.00	.00	.00
Calanus finmarchius	.14	5.75	2.58	.63	.00	.00
Centropages typicus	.00	.00	.00	.01	.00	.00
Temora longicaudata	.35	.88	.36	.01	.05	.00
Euchaeta norvegica	.00	.04	.08	.00	.00	.00
Gammaridea	.00	.02	.01	.00	.00	.00
Hyperiidea	.00	1.64	5.56	4.93	1.69	.06
Mysidacea	.30	3.40	1.26	.21	.24	.00
Euphausiacea	.00	16.53	19.31	9.53	12.51	3.12
Crangon vulgaris	.00	.01	.04	.25	.00	.01
Sagitta setosa	.00	.04	.04	.02	.00	.00
Plaice eggs	.00	.07	.15	.00	.00	.00
Other fish eggs	.00	.00	.00	.00	.00	.00
Clupeoid post-larvae	.00	1.78	3.56	.71	.36	.09
Goby post-larvae	.00	.05	.10	.20	.20	.00
Other fish post-larvae	.00	.15	.10	.15	.20	.00
Total	.80	30.38	33.19	16.66	15.26	3.28
August/September 1986						
Calanus finmarchius	.00	.56	.91	.38	.69	.05
Temora longicaudata	.00	.00	.00	.00	.00	.00
Hyperiidea	.00	.00	.00	.01	.01	.00
Ostracods	.00	.00	.00	.00	.00	.00
Mysidacea	.00	.03	.05	.04	.01	.00
Euphausiacea	.00	1.79	6.80	25.59	47.95	11.37
Decapod zoea	.00	.00	.01	.00	.01	.00
Sagitta setosa	.00	.01	.01	.00	.00	.00
Clupeoid post-larvae	.00	.08	.72	.00	.00	.00
Norway pout post-larvae	.00	.00	.00	.16	.56	.00
Other fish post-larvae	.00	.00	.00	.05	.00	.05
Ammodytes	.00	.00	.00	.01	.01	.00
Total	.00	2.48	8.50	26.24	49.24	11.47

Table 45

Herring diet (as a % of wet weight) at length in February and August

Length	5-9	10-14	15-19	20-24	25-29	30-34
February 1983						
Paracalanus parvus	.00	.00	.02	.00	.00	.00
Calanus finmarchius	.00	.00	4.48	.14	.00	.00
Temora longicaudata	.00	.00	.01	.00	.00	.00
Hyperiidea	.00	.00	3.58	9.73	.40	.00
Euphausiacea	.00	.00	89.08	89.85	99.60	.00
Plaice eggs	.00	.00	2.82	.28	.00	.00
Sagitta setosa	.00	.00	.02	.00	.00	.00
February 1984						
Paracalanus parvus	1.74	.05	.09	.03	.48	.00
Calanus finmarchius	97.57	20.56	4.73	5.00	1.31	.01
Temora longicaudata	.69	1.85	2.70	1.42	17.46	8.10
Hyperiidea	.00	15.92	5.14	22.48	11.94	4.99
Mysidacea	.00	17.74	18.11	3.98	1.76	.34
Euphausiacea	.00	38.54	41.92	48.04	30.29	40.42
Sagitta setosa	.00	.49	.12	.23	.07	.00
Plaice eggs	.00	1.95	.44	1.66	.70	.01
Other fish eggs	.00	.07	.01	.38	.49	.00
Clupeoid post-larvae	.00	2.83	26.75	16.79	35.50	46.13
February 1986						
Paracalanus parvus	.87	.10	.10	.00	.00	.00
Pseudocalanus elongatus	.00	.00	.00	.00	.00	.00
Calanus finmarchius	17.37	18.91	7.79	3.76	.02	.00
Centropages typicus	.00	.00	.00	.04	.00	.00
Temora longicaudata	44.30	2.90	1.08	.08	.36	.00
Euchaeta norvegica	.00	.14	.26	.00	.00	.00
Gammaridea	.16	.06	.02	.00	.00	.00
Hyperiidea	.17	5.41	16.76	29.63	11.09	1.98
Mysidacea	37.11	11.18	3.80	1.24	1.58	.00
Euphausiacea	.00	54.41	58.16	57.23	81.98	95.09
Crangon vulgaris	.00	.02	.11	1.51	.00	.21
Sagitta setosa	.01	.13	.13	.12	.00	.00
Plaice eggs	.00	.22	.46	.01	.01	.00
Other fish eggs	.00	.00	.00	.00	.00	.00
Clupeoid post-larvae	.00	5.86	10.73	4.28	2.33	2.71
Goby post-larvae	.00	.16	.30	1.20	1.31	.00
Other fish post-larvae	.00	.49	.30	.90	1.31	.00
August/September 1986						
Calanus finmarchius	22.65	22.65	10.75	1.45	1.41	.42
Temora longicaudata	.09	.09	.01	.00	.00	.00
Hyperiidea	.18	.18	.00	.04	.02	.04
Ostracods	.00	.00	.00	.00	.00	.00
Mysidacea	1.23	1.23	.64	.14	.02	.00
Euphausiacea	72.14	72.14	79.98	97.54	97.37	99.10
Decapod zoea	.00	.00	.06	.00	.01	.00
Sagitta setosa	.49	.49	.11	.01	.01	.00
Clupeoid post-larvae	3.21	3.21	8.45	.00	.00	.00
Norway pout post-larvae	.00	.00	.00	.61	1.14	.00
Other fish post-larvae	.00	.00	.00	.19	.00	.44
Ammodytes	.00	.00	.00	.02	.01	.00

Table 46

Herring age/length key: percentage of fish at age belonging to particular length groups

	Age						
Size	0	1	2	3	4	5	6+
<10	50.0	1.0	.0	.0	.0	.0	.0
10-14	50.0	43.5	.3	.0	.0	.0	.0
15-19	.0	55.5	16.3	2.2	.0	.0	.0
20-24	.0	.0	64.6	23.7	.0	.0	.0
25-29	.0	.0	18.8	73.1	86.3	70.8	38.1
30+	.0	.0	.0	1.1	13.8	29.2	61.9

Table 47

Diet (% by weight) of herring, by age and quarter

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 1							Quarter 2						
Paracalanus parvus		.08	.05	.12	.14	.11	.06		.00	.00	.00	.00	.00	.00
Pseudocalanus elongatus		.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00
Calanus finmarchius		12.30	2.99	1.15	.38	.32	.17		16.05	3.03	1.61	1.27	1.12	.80
Centropages typicus		.00	.01	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00
Temora longicaudata		1.96	1.65	4.53	5.68	5.39	4.77		.04	.00	.00	.00	.00	.00
Euchaeta norvegica		.08	.01	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00
Gammaridea		.02	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00
Hyperiidea		9.36	16.20	10.81	7.22	6.55	5.13		.08	.03	.02	.02	.02	.03
Ostracods		.00	.00	.00	.00	.00	.00		.00	.00	.00	.00	.00	.00
Mysidacea		10.53	2.57	1.39	.98	.84	.53		.90	.20	.06	.02	.02	.01
Euphausiacea		55.21	65.70	69.11	70.23	69.79	68.85		76.49	94.55	97.06	97.61	97.88	98.44
Crangon vulgaris		.02	.33	.12	.01	.03	.07		.00	.00	.00	.00	.00	.00
Decapod zoea		.00	.00	.00	.00	.00	.00		.03	.01	.01	.01	.01	.00
Sagitta setosa		.18	.10	.05	.02	.02	.01		.28	.03	.01	.01	.01	.00
Plaice eggs		1.16	.67	.35	.20	.17	.09		.00	.00	.00	.00	.00	.00
Other fish eggs		.02	.11	.15	.14	.12	.06		.00	.00	.00	.00	.00	.00
Clupeoid post-larvae		8.82	8.95	11.41	14.23	16.06	19.92		6.12	1.39	.18	.00	.00	.00
Norway pout post-larvae		.00	.00	.00	.00	.00	.00		.00	.61	.98	.98	.81	.43
Goby post-larvae		.09	.36	.42	.38	.31	.17		.00	.00	.00	.00	.00	.00
Other fish post-larvae		.16	.29	.39	.38	.31	.17		.00	.12	.05	.06	.13	.27
Ammodytes		.00	.00	.00	.00	.00	.00		.00	.02	.01	.01	.01	.00
	Quarter 3							Quarter 4						
Paracalanus parvus	.00	.00	.00	.00	.00	.00	.00	.69	.08	.05	.12	.14	.11	.06
Pseudocalanus elongatus	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Calanus finmarchius	22.65	16.05	3.03	1.61	1.27	1.12	.80	38.60	12.30	2.99	1.15	.38	.32	.17
Centropages typicus	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00	.00
Temora longicaudata	.09	.04	.00	.00	.00	.00	.00	12.44	1.96	1.65	4.53	5.68	5.39	4.77
Euchaeta norvegica	.00	.00	.00	.00	.00	.00	.00	.03	.08	.01	.00	.00	.00	.00
Gammaridea	.00	.00	.00	.00	.00	.00	.00	.05	.02	.00	.00	.00	.00	.00
Hyperiidea	.18	.08	.03	.02	.02	.02	.03	5.38	9.36	16.20	10.81	7.22	6.55	5.13
Ostracods	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Mysidacea	1.23	.90	.20	.06	.02	.02	.01	16.51	10.53	2.57	1.39	.98	.84	.53
Euphausiacea	72.14	76.49	94.55	97.06	97.61	97.88	98.44	23.24	55.21	65.70	69.11	70.23	69.79	68.85
Crangon vulgaris	.00	.00	.00	.00	.00	.00	.00	.01	.02	.33	.12	.01	.03	.07
Decapod zoea	.00	.03	.01	.01	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00
Sagitta setosa	.49	.28	.03	.01	.01	.01	.00	.16	.18	.10	.05	.02	.02	.01
Plaice eggs	.00	.00	.00	.00	.00	.00	.00	.54	1.16	.67	.35	.20	.17	.09
Other fish eggs	.00	.00	.00	.00	.00	.00	.00	.02	.02	.11	.15	.14	.12	.06
Clupeoid post-larvae	3.21	6.12	1.39	.18	.00	.00	.00	2.17	8.82	8.95	11.41	14.23	16.06	19.92
Norway pout post-larvae	.00	.00	.61	.98	.98	.81	.43	.00	.00	.00	.00	.00	.00	.00
Goby post-larvae	.00	.00	.00	.00	.00	.00	.00	.04	.09	.36	.42	.38	.31	.17
Other fish post-larvae	.00	.00	.12	.05	.06	.13	.27	.12	.16	.29	.39	.38	.31	.17
Ammodytes	.00	.00	.02	.01	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00

Table 48

Herring food consumption rates (as % biomass) by age and quarter

Age	0	1	2	3	4	5	6+
Quarter 1		1.02	.80	.75	.73	.70	.68
Quarter 2		1.70	1.60	1.50	1.45	1.40	1.35
Quarter 3	2.00	1.70	1.60	1.50	1.45	1.40	1.35
Quarter 4	1.50	1.22	1.06	.99	.96	.92	.89

Table 49

A; numbers of herring (x1000) at age ("0" group 1 July, "1+" 1 January; output from MSVPA). B; numbers of herring (x1000) by age and quarter derived from MSVPA and "decay function (Fig. 2). C; body-weight of herring (g) by age and quarter (MSVPA output). D; biomass of herring (tonnes) by age and quarter (Column B * Column C). E; Sparholt (1990) total quarterly herring biomass partitioned by age using MSVPA derived proportions of biomass at age

	A	B				C				D				E				
	Numbers	Numbers derived from MSVPA				Body-weight (MSVPA output)				Biomass derived from MSVPA				Age partitioned Sparholt biomass				
		Quarter				Quarter				Quarter				Quarter				
Age		1	2	3	4	1	2	3	4	1	2	3	4	Age	1	2	3	4
0	4.445e7	0	0	2.746e7	2.188e7	0	2	7	14	0	0	192190	306269	0	0	0	131722	275244
1	1.759e7	1.743e7	1.389e7	1.107e7	8817446	12	31	63	80	209169	430547	697174	705396	1	153356	277009	477826	633941
2	6505870	7025624	5597924	4460352	3553949	75	135	134	124	526922	755720	597687	440690	2	386321	486222	409640	396049
3	2448125	2831740	2256293	1797784	1432450	117	169	190	155	331314	381313	341579	222030	3	242907	245333	234110	199539
4	899089	1141358	909419	724613	577362	141	201	215	174	160931	182793	155792	100461	4	117989	117607	106776	90284
5	382275	460034	366549	292061	232711	159	215	227	171	73145	78808	66298	39794	5	53628	50704	45439	35763
6	160392	185421	147741	117718	93796	165	241	228	201	30594	35606	26840	18853	6+	38799	38458	32155	29180
7	61795	74735	59548	47447	37805	184	259	260	222	13751	15423	12336	8393					
8	29858	30123	24001	19124	15238	198	260	285	236	5964	6240	5450	3596					
9	20000	12141	9674	7708	6142	215	259	297	265	2610	2506	2289	1628					

Total daily consumption (tonnes) and the daily consumption of each prey (tonnes) by herring, by age and quarter

Age	0	1	2	3	4	5	6+	0	1	2	3	4	5	6+
	Quarter 1							Quarter 2						
Total food consumption	.0	1564.2	3090.6	1821.8	855.4	375.4	261.9	.0	4709.2	7779.5	3680.0	1705.3	709.9	519.2
Paracalanus parvus	.0	1.3	1.5	2.2	1.2	.4	.2	.0	.0	.0	.0	.0	.0	.0
Pseudocalanus elongatus	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Calanus finmarchius	.0	192.4	92.5	20.9	3.3	1.2	.5	.0	755.7	236.0	59.3	21.7	8.0	4.2
Centropages typicus	.0	.0	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Temora longicaudata	.0	30.6	51.0	82.6	48.6	20.2	12.5	.0	2.0	.2	.1	.1	.0	.0
Euchaeta norvegica	.0	1.2	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Gammaridea	.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Hyperiidea	.0	146.3	500.7	196.9	61.7	24.6	13.4	.0	3.9	2.5	.9	.4	.2	.2
Ostracods	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0
Mysidacea	.0	164.7	79.6	25.2	8.4	3.2	1.4	.0	42.5	15.8	2.3	.3	.1	.0
Euphausiacea	.0	863.6	2030.5	1259.0	600.8	262.0	180.3	.0	3602.1	7355.7	3571.7	1664.6	694.8	511.1
Crangon vulgaris	.0	.4	10.2	2.2	.1	.1	.2	.0	.0	.0	.0	.0	.0	.0
Decapod zoea	.0	.0	.0	.0	.0	.0	.0	.0	1.6	.9	.3	.2	.1	.0
Sagitta setosa	.0	2.9	3.0	.9	.2	.1	.0	.0	13.3	2.1	.4	.1	.1	.0
Plaice eggs	.0	18.1	20.7	6.4	1.7	.6	.2	.0	.0	.0	.0	.0	.0	.0
Other fish eggs	.0	.3	3.5	2.7	1.2	.4	.2	.0	.0	.0	.0	.0	.0	.0
Clupeoid post-larvae	.0	138.0	276.7	207.9	121.8	60.3	52.2	.0	288.1	108.1	6.7	.0	.0	.0
Norway pout post-larvae	.0	.0	.0	.0	.0	.0	.0	.0	.0	47.2	35.9	16.7	5.7	2.2
Goby post-larvae	.0	1.4	11.0	7.6	3.2	1.2	.4	.0	.0	.0	.0	.0	.0	.0
Other fish post-larvae	.0	2.6	9.1	7.2	3.2	1.2	.4	.0	.0	9.6	1.8	1.0	.9	1.4
Ammodytes	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.2	.5	.2	.1	.0
	Quarter 3							Quarter 4						
Total food consumption	2634.4	8123.0	6554.2	3511.6	1548.2	636.1	434.1	4128.7	7734.1	4182.3	1975.4	864.0	330.4	260.0
Paracalanus parvus	.0	.0	.0	.0	.0	.0	.0	28.5	6.4	2.0	2.4	1.2	.4	.2
Pseudocalanus elongatus	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0
Calanus finmarchius	596.6	1303.5	198.9	56.5	19.7	7.1	3.5	1593.8	951.5	125.2	22.7	3.3	1.0	.4
Centropages typicus	.0	.0	.0	.0	.0	.0	.0	.0	.1	.3	.1	.0	.0	.0
Temora longicaudata	2.3	3.5	.2	.1	.0	.0	.0	513.4	151.5	69.0	89.5	49.1	17.8	12.4
Euchaeta norvegica	.0	.0	.0	.0	.0	.0	.0	1.4	6.0	.6	.0	.0	.0	.0
Gammaridea	.0	.0	.0	.0	.0	.0	.0	2.3	1.3	.0	.0	.0	.0	.0
Hyperiidea	4.7	6.7	2.1	.8	.3	.2	.1	221.9	723.6	677.5	213.5	62.3	21.6	13.3
Ostracods	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Mysidacea	32.4	73.4	13.3	2.2	.3	.1	.0	681.5	814.2	107.7	27.4	8.5	2.8	1.4
Euphausiacea	1900.6	6213.4	6197.2	3408.3	1511.3	622.6	427.3	959.4	4270.1	2747.7	1365.2	606.8	230.6	179.0
Crangon vulgaris	.0	.0	.0	.0	.0	.0	.0	.2	1.9	13.9	2.4	.1	.1	.2
Decapod zoea	.1	2.8	.8	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
Sagitta setosa	13.0	22.9	1.7	.4	.1	.0	.0	6.5	14.3	4.0	.9	.2	.1	.0
Plaice eggs	.0	.0	.0	.0	.0	.0	.0	22.3	89.6	28.0	7.0	1.8	.6	.2
Other fish eggs	.0	.0	.0	.0	.0	.0	.0	.7	1.3	4.7	3.0	1.2	.4	.2
Clupeoid post-larvae	84.7	496.9	91.1	6.4	.0	.0	.0	89.8	682.5	374.4	225.4	123.0	53.1	51.8
Norway pout post-larvae	.0	.0	39.8	34.3	15.2	5.1	1.9	.0	.0	.0	.0	.0	.0	.0
Goby post-larvae	.0	.0	.0	.0	.0	.0	.0	1.7	7.1	14.9	8.2	3.3	1.0	.4
Other fish post-larvae	.0	.0	8.1	1.7	.9	.8	1.2	5.1	12.6	12.3	7.8	3.3	1.0	.4
Ammodytes	.0	.0	1.0	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0

Table 51

Total daily consumption of food by sprat and sandeels in each quarter of the year

	Quarter			
	1	2	3	4
Sprat	1468.80	3060.00	3801.60	3276.00
Sandeel	15871.20	29427.00	33545.60	27053.00

Table 52

Derivation of the carbon content (as a proportion of wet weight) for each prey guild

Prey guild	Carbon as proportion wet weight	Reference
Phytoplankton flagelate	0.07	S J Hay (pers. comm.)
Meso-zooplankton herbivore	0.10	see: Raymont *et al.* (1971); Hirota (1981); Wiebe *et al.* (1975); Båmstedt (1981)
Meso-zooplankton omnivore	0.10	
Meso-zooplankton carnivore	0.10	
Macro-benthos filter-feeder	0.04	see: Rumohr *et al.* (1987)
Macro-benthos deposit-feeder	0.08	
Macro-benthos carnivore	0.08	
Mega-benthos	0.08	
Pelagic plantivorous fish	0.162	see: Greenstreet (1992)
Pelagic piscivorous fish	0.184	
Demersal benthivorous fish	0.107	
Demersal piscivorous fish	0.103	

Table 53

Daily food consumption by cod in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phytoplankton flagellate	0	0	0	0	.00	.00	.00	.00	.0	.0	.0	.0
Meso-zooplankton carnivores	46	304	208	102	.08	.53	.36	.18	8.0	53.4	36.5	17.9
Macro-benthos filter feeders	67	18	20	19	.12	.03	.04	.03	4.7	1.3	1.4	1.3
Macro-benthos deposit feeders	189	207	286	204	.33	.36	.50	.36	26.5	29.0	40.2	28.6
Macro-benthos carnivores	548	996	996	977	.96	1.75	1.75	1.71	76.9	139.8	139.9	137.1
Mega-benthos	17	64	23	1	.03	.11	.04	.00	2.3	9.0	3.3	.2
Pelagic planktivores	542	795	1165	384	.95	1.39	2.04	.67	154.1	226.0	331.0	109.3
Pelagic piscivores	0	0	52	80	.00	.00	.09	.14	.0	.0	16.9	25.8
Demersal benthivores	502	647	650	432	.88	1.13	1.14	.76	94.2	121.4	122.1	81.1
Demersal piscivores	1097	521	803	652	1.93	.91	1.41	1.14	198.3	94.2	145.0	117.8

Table 54

Daily food consumption by haddock in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Meso-zooplankton omnivores	0	82	1	0	.00	.14	.00	.00	.0	14.3	.2	.0
Meso-zooplankton carnivores	323	739	1914	219	.57	1.30	3.36	.38	56.6	129.7	335.7	38.4
Macro-benthos filter feeders	326	389	568	828	.57	.68	1.00	1.45	22.9	27.3	39.9	58.1
Macro-benthos deposit feeders	1073	936	1235	1360	1.88	1.64	2.17	2.39	150.5	131.4	173.3	190.8
Macro-benthos carnivores	312	226	408	725	.55	.40	.72	1.27	43.8	31.7	57.3	101.7
Mega-benthos	769	1183	1135	900	1.35	2.08	1.99	1.58	107.9	166.0	159.2	126.3
Pelagic planktivores	1029	892	3004	2297	1.80	1.56	5.27	4.03	292.4	253.4	853.6	652.9
Demersal benthivores	328	1687	2488	1907	.57	2.96	4.36	3.35	61.5	316.6	467.0	357.9
Demersal piscivores	0	0	20	9	.00	.00	.04	.02	.0	.0	3.7	1.6

Table 55

Daily food consumption by whiting in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Meso-zooplankton omnivores	3	10	342	98	.00	.02	.60	.17	.5	1.7	60.0	17.2
Meso-zooplankton carnivores	732	1514	331	73	1.28	2.66	.58	.13	128.5	265.5	58.1	12.7
Macro-benthos filter feeders	69	133	69	187	.12	.23	.12	.33	4.8	9.3	4.9	13.1
Macro-benthos deposit feeders	157	115	756	521	.27	.20	1.33	.91	22.0	16.1	106.1	73.1
Macro-benthos carnivores	983	296	1648	1579	1.73	.52	2.89	2.77	138.0	41.6	231.3	221.7
Mega-benthos	0	2	120	2	.00	.00	.21	.00	.0	.3	16.9	.2
Pelagic planktivores	2176	3779	4385	4195	3.82	6.63	7.69	7.36	618.6	1074.0	1246.2	1192.4
Pelagic piscivores	0	1	2	0	.00	.00	.00	.00	.0	.2	.5	.0
Demersal benthivores	128	55	112	308	.23	.10	.20	.54	24.1	10.3	21.1	57.9
Demersal piscivores	129	147	1337	703	.23	.26	2.35	1.23	23.4	26.6	241.6	127.1

Table 56

Daily food consumption by saithe in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Meso-zooplankton omnivores	0	0	0	0	.00	.00	.00	.00	.0	.0	.0	.0
Meso-zooplankton carnivores	1796	2259	2666	2522	3.15	3.96	4.68	4.42	315.1	396.4	467.8	442.4
Macro-benthos filter feeders	0	13	9	0	.00	.02	.02	.00	.0	.9	.6	.0
Macro-benthos deposit feeders	0	0	0	0	.00	.00	.00	.00	.0	.0	.0	.0
Macro-benthos carnivores	8	6	6	5	.01	.01	.01	.01	1.1	.8	.8	.8
Mega-benthos	0	1	0	0	.00	.00	.00	.00	.0	.1	.1	.0
Pelagic planktivores	3533	2250	2567	3360	6.20	3.95	4.50	5.89	1004.2	639.4	729.6	954.9
Demersal benthivores	8	0	0	6	.01	.00	.00	.01	1.5	.0	.0	1.0
Demersal piscivores	540	1733	2251	571	.95	3.04	3.95	1.00	97.6	313.1	406.7	103.1

Table 57

Daily food consumption by plaice in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Macro-benthos filter feeder	2440	2642	1941	3886	4.28	4.63	3.41	6.82	171.3	185.4	136.2	272.7
Macro-benthos deposit feeder	7643	20420	8140	13615	13.41	35.83	14.28	23.89	1072.8	2866.0	1142.5	1910.9

Table 58

Daily food consumption by common dab in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Macro-benthos filter feeder	195	1778	5498	386	.34	3.12	9.65	.68	13.7	124.8	385.8	27.1
Macro-benthos deposit feeder	1661	958	3299	1349	2.91	1.68	5.79	2.37	233.1	134.4	463.0	189.4
Macro-benthos carnivore	1466	1368	11216	5591	2.57	2.40	19.68	9.81	205.7	192.0	1574.2	784.6
Mega-benthos	6449	9576	1979	11952	11.31	16.80	3.47	20.97	905.1	1344.0	277.8	1677.5

Table 59

Daily food consumption by lemon sole in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Macro-benthos filter feeders	337	592	633	181	.59	1.04	1.11	.32	23.7	41.5	44.5	12.7
Macro-benthos deposit feeders	1063	1863	1995	570	1.86	3.27	3.50	1.00	149.2	261.5	280.1	80.0
Macro-benthos carnivores	80	141	151	43	.14	.25	.26	.08	11.3	19.7	21.1	6.0
Mega-benthos	28	49	52	15	.05	.09	.09	.03	3.9	6.9	7.4	2.1
Demersal benthivores	8	14	15	4	.01	.02	.03	.01	1.5	2.7	2.9	.8

Table 60

Daily food consumption by mackerel in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Meso-zooplankton omnivores	3	687	621	652	.01	1.20	1.09	1.1	4.6	120.4	108.9	114.3
Meso-zooplankton carnivores	458	492	758	1100	.80	.86	1.33	1.93	80.3	86.3	133.1	193.0
Macro-benthos filter feeders	10	41	222	193	.02	.07	.39	.34	.7	2.9	15.6	13.5
Macro-benthos deposit feeders	0	6	43	66	.00	.01	.08	.11	.0	.9	6.1	9.2
Macro-benthos carnivores	2	1	307	23	.00	.00	.54	.04	.3	.2	43.0	3.2
Pelagic planktivores	37	1004	1098	681	.06	1.76	1.93	1.19	10.5	285.3	312.2	193.6
Pelagic piscivores	0	5	0	0	.00	.01	.00	.00	.0	1.7	.0	.0
Demersal benthivores	0	0	1	0	.00	.00	.00	.00	.0	.0	.1	.0
Demersal piscivores	0	0	10	0	.00	.00	.02	.00	.0	.0	1.8	.0

Table 61

Daily food consumption by horse mackerel in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Meso-zooplankton omnivores	7	927	1922	2172	.01	1.63	3.37	3.8	11.3	162.7	337.1	381.0
Meroplankton	0	12	24	27	.00	.02	.04	.05	.0	2.0	4.2	4.8
Macro-benthos carnivores	16	2047	4243	4796	.03	3.59	7.44	8.41	2.2	287.3	595.5	673.1
Pelagic planktivores	7	879	1822	2059	.01	1.54	3.20	3.61	1.9	249.8	517.7	585.1
Demersal benthivores	0	52	107	121	.00	.09	.19	.21	.1	9.7	20.1	22.7
Demersal piscivores	37	4787	9922	11213	.06	8.40	17.41	19.67	6.7	865.0	1792.8	2026.3

Table 62

Daily food consumption by Norway pout in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Meso-zooplankton omnivores	2208	9304	10601	2467	3.87	16.32	18.60	4.33	387.4	1632.3	1859.8	432.8
Meso-zooplankton carnivores	11897	7597	7905	11466	20.87	13.33	13.87	20.12	2087.3	1332.8	1386.9	2011.6
Macro-benthos filter feeder	68	421	302	68	.12	.74	.53	.124	.8	29.6	21.2	4.8
Macro-benthos deposit feeder	98	658	688	103	.17	1.15	1.21	.18	13.7	92.4	96.6	14.4
Macro-benthos carnivore	0	814	764	0	.00	1.43	1.34	.00	.0	114.2	107.3	.0
Mega-benthos	14	0	0	7	.02	.00	.00	.01	1.9	.0	.0	1.0
Pelagic planktivores	0	6	1	0	.00	.01	.00	.00	.0	1.6	.4	.0

Table 63

Daily food consumption by herring in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Meso-zooplankton omnivores	563	1088	2192	3642	.99	1.91	3.85	6.39	98.8	190.8	384.6	639.0
Meso-zooplankton carnivores	5205	17416	20319	10393	9.13	30.55	35.65	18.23	913.1	3055.4	3564.7	1823.3
Meroplankton	56	3	4	161	.10	.01	.01	.28	9.9	.6	.7	28.2
Macro-benthos filter feeders	944	8	15	1937	1.66	.01	.03	3.40	66.2	.6	1.1	136.0
Macro-benthos deposit feeders	282	61	122	1643	.50	.11	.21	2.88	39.6	8.6	17.1	230.7
Macro-benthos carnivores	13	0	0	19	.02	.00	.00	.03	1.9	.0	.0	2.6
Pelagic planktivores	857	513	777	1600	1.50	.90	1.36	2.81	243.5	145.7	220.8	454.7
Demersal benthivores	25	0	0	37	.04	.00	.00	.06	4.7	.0	.0	6.9
Demersal piscivores	24	15	13	42	.04	.03	.02	.07	4.3	2.7	2.3	7.7

Table 64

Daily food consumption by sprat in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Meso-zooplankton omnivores	1469	3060	3802	3276	2.58	5.37	6.67	5.75	257.7	536.8	666.9	574.7

Table 65

Daily food consumption by sandeel in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Meso-zooplankton omnivores	15871	29427	33546	27053	27.84	51.63	58.85	47.46	2784.4	5162.6	5885.2	4746.1

Table 66

Daily food consumption by the Demersal piscivore group in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phyto-plankton flagellate	0	0	0	0	.00	.00	.00	.00	.0	.0	.0	.0
Meso-zooplankton omnivores	3	118	457	134	.01	.21	.80	.23	.6	20.8	80.1	23.4
Meso-zooplankton carnivores	3628	6225	6804	3972	6.36	10.92	11.94	6.97	636.4	1092.1	1193.6	696.8
Macro-benthos filter feeders	580	715	886	1409	1.02	1.25	1.55	2.47	40.7	50.2	62.2	98.9
Macro-benthos deposit feeders	1776	1626	3027	2840	3.12	2.85	5.31	4.98	249.3	228.3	424.8	398.7
Macro-benthos carnivores	2319	1969	4065	4478	4.07	3.46	7.13	7.86	325.5	276.4	570.5	628.4
Mega-benthos	984	1615	1700	1230	1.73	2.83	2.98	2.16	138.1	226.7	238.5	172.6
Pelagic planktivores	9117	9972	14780	13947	15.99	17.49	25.93	24.47	2591.1	2834.1	4200.5	3963.8
Pelagic piscivores	0	1	72	109	.00	.00	.13	.19	.1	.3	23.1	35.2
Demersal benthivores	1209	3087	4320	3614	2.12	5.42	7.58	6.34	227.0	579.5	810.9	678.3
Demersal piscivores	2213	3103	5862	2637	3.88	5.44	10.28	4.63	399.9	560.8	1059.3	476.4

Table 67

Daily food consumption by the Demersal benthivore group in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Macro-benthos filter feeder	3711	6466	10205	5205	6.51	11.34	17.90	9.13	260.4	453.8	716.1	365.3
Macro-benthos deposit feeder	12940	29987	16982	18160	22.70	52.61	29.79	31.86	1816.1	4208.7	2383.5	2548.8
Macro-benthos carnivore	1929	1946	14369	6586	3.39	3.41	25.21	11.55	270.8	273.2	2016.7	924.3
Mega-benthos	8084	12418	2568	13990	14.18	21.79	4.51	24.54	1134.6	1742.9	360.5	1963.6
Demersal benthivores	10	18	19	5	.02	.03	.03	.01	1.9	3.5	3.6	1.0

Table 68

Daily food consumption by the Pelagic piscivore group in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Meso-zooplankton omnivores	10	1614	2543	2824	.02	2.83	4.46	4.95	1.8	283.1	446.1	495.4
Meso-zooplankton carnivores	458	492	758	1100	.80	.86	1.33	1.93	80.3	86.3	133.1	193.0
Meroplankton	0	12	24	27	.00	.02	.04	.05	.0	2.0	4.2	4.8
Macro-benthos filter feeders	10	41	222	193	.02	.07	.39	.34	.7	2.9	15.6	13.5
Macro-benthos deposit feeders	0	6	43	66	.00	.01	.08	.11	.0	.9	6.1	9.2
Macro-benthos carnivores	18	2049	4550	4819	.03	3.59	7.98	8.45	2.5	287.5	638.6	676.3
Pelagic planktivores	44	1883	2920	2740	.08	3.30	5.12	4.81	12.5	535.1	829.9	778.7
Pelagic piscivores	0	5	0	0	.00	.01	.00	.00	.0	1.7	.0	.0
Demersal benthivores	0	52	107	121	.00	.09	.19	.21	.1	9.7	20.2	22.7
Demersal piscivores	37	4787	9931	11213	.06	8.40	17.42	19.67	6.7	865.0	1794.6	2026.3

Table 69

Daily food consumption by the Pelagic planktivore group in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Meso-zooplankton omnivores	20139	43334	51169	37565	35.33	76.02	89.77	65.90	3533.2	7602.4	8977.0	6590.4
Meso-zooplankton carnivores	17126	25279	28803	22535	30.05	44.35	50.53	39.54	3004.6	4434.8	5053.2	3953.6
Meroplankton	56	3	4	166	.10	.01	.01	.29	9.9	.6	.8	29.1
Macro-benthos filter feeders	1014	434	323	2068	1.78	.76	.57	3.63	71.1	30.4	22.7	145.1
Macro-benthos deposit feeders	381	727	827	1800	.67	1.28	1.45	3.16	53.4	102.0	116.0	252.7
Macro-benthos carnivores	13	822	780	19	.02	1.44	1.37	.03	1.9	115.4	109.5	2.7
Mega-benthos	14	0	0	7	.02	.00	.00	.01	1.9	.0	.0	1.0
Pelagic planktivores	858	524	794	1649	1.51	.92	1.39	2.89	243.9	148.9	225.7	468.8
Demersal benthivores	25	0	0	38	.04	.00	.00	.07	4.7	.0	.0	7.1
Demersal piscivores	24	15	13	44	.04	.03	.02	.08	4.3	2.7	2.3	7.9

Table 70

Daily food consumption by the whole fish assemblage of the North Sea in each quarter of the year

	Tonnes/day				mg/sq m/day				µg C/sq m/day			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phytoplankton flagellate	0	0	0	0	.00	.00	.00	.00	.0	.0	.0	.0
Meso-zooplankton omnivores	20153	45066	54168	40522	35.36	79.06	95.03	71.09	3535.7	7906.3	9503.2	7109.1
Meso-zooplankton carnivores	21212	31996	36365	27607	37.21	56.13	63.80	48.43	3721.3	5613.3	6379.9	4843.4
Meroplankton	56	15	28	193	.10	.03	.05	.34	9.9	2.6	5.0	33.9
Macro-benthos filter feeders	5314	7657	11636	8875	9.32	13.43	20.41	15.57	372.9	537.3	816.6	622.8
Macro-benthos deposit feeders	15097	32346	20879	22867	26.49	56.75	36.63	40.12	2118.8	4539.8	2930.3	3209.4
Macro-benthos carnivores	4280	6787	23763	15902	7.51	11.91	41.69	27.90	600.6	952.6	3335.2	2231.8
Mega-benthos	9082	14033	4268	15227	15.93	24.62	7.49	26.71	1274.6	1969.6	599.0	2137.2
Pelagic planktivores	10019	12379	18494	18336	17.58	21.72	32.45	32.17	2847.4	3518.1	5256.2	5211.3
Pelagic piscivores	0	6	72	109	.00	.01	.13	.19	.1	2.0	23.1	35.2
Demersal benthivores	1245	3157	4447	3777	2.18	5.54	7.80	6.63	233.7	592.6	834.7	709.1
Demersal piscivores	2273	7905	15806	13894	3.99	13.87	27.73	24.37	410.8	1428.5	2856.2	2510.6

Table 71

Total annual consumption of each prey guild by the whole fish assemblage of the North Sea

	tonnes/day	mg/sq m/day	µg C/sq m/day
Phytoplankton flagellate	24	.04	2.9
Meso-zooplankton omnivores	14,591,750	25599.56	2559956.2
Meso-zooplankton carnivores	10,692,679	18759.09	1875908.6
Meroplankton	26,678	46.80	4680.4
Macro-benthos filter feeders	3,055,238	5360.07	214402.7
Macro-benthos deposit feeders	8,320,917	14598.10	1167848.0
Macro-benthos carnivores	4,629,271	8121.53	649722.2
Mega-benthos	3,888,171	6821.35	545708.3
Pelagic planktivores	5,404,476	9481.54	1536008.9
Pelagic piscivores	17,090	29.98	5516.8
Demersal benthivores	1,152,088	2021.21	216269.1
Demersal piscivores	3,638,926	6384.08	657560.4

Appendix I

List of species with biomass estimates provided in Sparholt (1990) and the fish feeding guild to which each species has been assigned.

Scientific name	Common name	Feeding guild
Scyliorhinus caniculus	Dogfish	Demersal piscivore
Galeus melastomus	Black-mouthed dogfish	Demersal piscivore
Galeorhinus galeus	Tope	Demersal piscivore
Mustelus mustelus	Smooth hound	Demersal piscivore
Squalus acanthias	Spurdog	Demersal piscivore
Etmopterus spinax	Velvet belly	Demersal piscivore
Raja brachyura	Blonde ray	Demersal benthivore
Raja clavata	Roker	Demersal benthivore
Raja montagui	Spotted ray	Demersal benthivore
Raja radiata	Starry ray	Demersal piscivore
Raja batis	Skate	Demersal benthivore
Raja fullonica	Shagreen ray	Demersal benthivore
Raja circularis	Sandy ray	Demersal benthivore
Raja naevus	Cuckoo ray	Demersal benthivore
Chimaera monstrosa	Rat fish	Demersal piscivore
Clupea harengus	Herring	Pelagic planktivore
Sprattus sprattus	Sprat	Pelagic planktivore
Alosa alosa	Allis shad	Pelagic planktivore
Salmo trutta	Sea-trout	Demersal piscivore
Argentina sphyraena	Argentine	Pelagic planktivore
Argentina silus	Greater argentine	Pelagic planktivore
Lophius piscatorius	Angler	Demersal piscivore
Gadus morhua	Cod	Demersal piscivore
Gadiculus argenteus	Silvery pout	Pelagic planktivore
Melanogrammus aeglefinus	Haddock	Demersal piscivore
Merlangius merlangus	Whiting	Demersal piscivore
Trisopterus minutus	Poor cod	Demersal piscivore
Micromesistius poutassou	Blue whiting	Pelagic planktivore
Trisopterus luscus	Bib	Demersal piscivore
Trisopterus esmarki	Norway pout	Pelagic planktivore
Pollachius virens	Saithe	Demersal piscivores
Pollachius pollachius	Pollack	Demersal piscivore
Brosme brosme	Torsk	Demersal piscivore
Ciliata septentrionalis	Northern rockling	Demersal piscivore
Enchelyopus cimbrius	Four-bearded rockling	Demersal piscivore
Gaidropsarus vulgaris	Three-bearded rockling	Demersal piscivore
Molva molva	Ling	Demersal piscivore

Scientific name	Common name	Feeding guild
Molva dypterygia	Blue ling	Demersal piscivore
Merluccius merluccius	Hake	Demersal piscivore
Zoarces viviparus	Viviparous blenny	Demersal benthivore
Sebastes marinus	Red-fish	Demersal piscivore
Sebastes viviparus	Norway haddock	Demersal piscivore
Trigla lucerna	Tub gurnard	Demersal piscivore
Eutrigla gurnardus	Grey gurnard	Demersal piscivore
Trigloporus lastoviza	Streaked gurnard	Demersal benthivore
Myoxocephalus scorpius	Bull-rout	Demersal benthivore
Taurulus bubalis	Sea-scorpion	Demersal benthivore
Agonus cataphractus	Hooknose	Demersal benthivore
Cyclopterus lumpus	Lumpsucker	Demersal piscivore
Liparis liparis	Sea-snail	Demersal benthivore
Trachurus trachurus	Horse mackerel	Pelagic piscivore
Echiichthys vipera	Lesser weever	Demersal benthivore
Trachinus draco	Greater weever	Demersal benthivore
Anarhichas minor	Spotted catfish	Demersal benthivore
Lumpenus lampretaeformis	Snake blenny	Demersal benthivore
Phollis gunnellus	Butterfish	Demersal benthivore
Ammodytes tobianus	Sandeel	Pelagic planktivore
Callionymidae	Dragonets	Demersal benthivore
Gobiidae	Gobies	Demersal benthivore
Scomber scomber	Mackerel	Pelagic piscivore
Scophthalmus rhombus	Brill	Demersal piscivore
Scophthalmus maximus	Turbot	Demersal piscivore
Lepidorhombus whiffiagonis	Megrim	Demersal piscivore
Arnoglossus laterna	Scaldfish	Demersal benthivore
Pleuronectes platessa	Plaice	Demersal benthivore
Platichthys flesus	Flounder	Demersal benthivore
Limanda limanda	Dab	Demersal benthivore
Microstomus kitt	Lemon sole	Demersal benthivore
Glyptocephalus cynoglossus	Witch	Demersal benthivore
Hippoglossides platessoides	Long rough dab	Demersal benthivore
Hippoglossus hippoglossus	Halibut	Demersal piscivore
Solea solea	Sole	Demersal benthivore
Buglossidium luteum	Solenette	Demersal benthivore

Appendix II

List of prey items found in stomach samples examined in fish diet studies and the prey life-history guild to which each item has been assigned.

Scientific name	Common name	Life history guild
PHAEOPHYTA	Phytoplankton	Phytoplankton flagellate
APPENDICULARIA	Oikopleura	Meso-zooplankton omnivore
PORIFERA	Sponges	Macro-benthos filter feeder
Hydroids	Hydrozoa	Macro-benthos filter feeder
CNIDARIA	Cnidarians	Meso-zooplankton carnivore
CTENOPHORA	Comb jellies	Meso-zooplankton carnivore
PLATYHELMINTHES	Flatworms	Macro-benthos carnivore
NEMERTEA	Ribbon worms	Macro-benthos carnivore
GEPHYREA	Group name of Pseudocoelomate phyla	Macro-benthos deposit feeder
RHYNCHOCOELA	Ribbon worms	Macro-benthos carnivore
PRIAPULIDA	Priapulid worms	Macro-benthos deposit feeder
POLYPLACOPHORA	Chitons	Macro-benthos deposit feeder
GASTROPODA	Footed shells	Macro-benthos deposit feeder
SCAPHOPODA	Tusk shells	Macro-benthos deposit feeder
Cultellus pelucidus	Bivalve	Macro-benthos filter feeder
Ensis ensis	Bivalve	Macro-benthos filter feeder
Abra alba	Bivalve	Macro-benthos deposit feeder
BIVALVIA	Bivalve shells	Macro-benthos filter feeder
CEPHALOPODA	Squids, octopii	Meso-zooplankton carnivore
Unidentified MOLLUSCA		Macro-benthos filter feeder Meroplankton
Pectinaria koreni	Polychaeta	Macro-benthos deposit feeder
Nephtys spp.	Polychaeta	Macro-benthos deposit feeder
POLYCHAETA	Segmented worms	Macro-benthos deposit feeder
ANNELLIDA	Segmented worms	Macro-benthos deposit feeder
ECHIURA	Spoon worms	Macro-benthos deposit feeder
SIPUNCULA	Peanut worms	Macro-benthos deposit feeder
Paracalanus parvus	Copepod	Meso-zooplankton omnivore
Pseudocalanus elongatus	Copepod	Meso-zooplankton omnivore
Calanus finmarchius	Copepod	Meso-zooplankton omnivore
Centropages typicus	Copepod	Meso-zooplankton omnivore

Scientific name	Common name	Life history guild
Temora longicaudata	Copepod	Meso-zooplankton omnivore
Calanoida	Copepod	Meso-zooplankton omnivore
Copepoda	Copepods	Meso-zooplankton omnivore
Ostracoda	Seed shrimps	Meso-zooplankton ominvore
Leptostraca		Macro-benthos filter feeder
Amblyops abreviata	Mysid	Macro-benthos deposit feeder
Boreomysis arctica	Mysid	Macro-benthos deposit feeder
Boreomysis nobilis	Mysid	Macro-benthos deposit feeder
Pseudomma affine	Mysid	Macro-benthos deposit feeder
Pseudomma roseum	Mysid	Macro-benthos deposit feeder
Erythrops serrata	Mysid	Macro-benthos deposit feeder
Mysidia	Opossum shrimps	Macro-benthos deposit feeder
Lampropidae	Cumaceans	Macro-benthos deposit feeder
Cumacea	Cumaceans	Macro-benthos deposit feeder
Tanaidacea	Tanaidaceans	Macro-benthos deposit feeder
Euchaeta norvegica	Zooplankton	Meso-zooplankton carnivore
Paraeuchaeta norvegica	Zooplankton	Meso-zooplankton carnivore
Flabellifera	Isopod	Macro-benthos deposit feeder
Valvifera	Isopod	Macro-benthos deposit feeder
Asellota	Isopod	Macro-benthos deposit feeder
Isopoda	Isopods	Macro-benthos deposit feeder
Parathemisto abyssorum	Amphipod	Macro-benthos filter feeder
Gammaridea	Amphipod	Macro-benthos filter feeder
Hyperiidea	Amphipod	Macro-benthos filter feeder
Caprellidea	Amphipod	Macro-benthos filter feeder
Amphipoda	"Sandhoppers"	Macro-benthos filter feeder
Meganyctiphanes norvegica	Euphausid	Meso-zooplankton carnivore
Thysanoessa raschii	Euphausid	Meso-zooplankton carnivore
Euphausiacea	Euphausids	Meso-zooplankton carnivore
Crangon crangon	Shrimp	Macro-benthos carnivore
Crangonidae	Shrimps	Macro-benthos carnivore
Pasiphaea tarda	Shrimp	Meso-zooplankton carnivore
Pasiphaeidae	Shrimps	Meso-zooplankton carnivore
Pandalus borealis	Prawn	Macro-benthos carnivore
Pandalidae	Prawns	Macro-benthos carnivore

Scientific name	Common name	Life history guild
Pontophilus norvegicus	Shrimp	Macro-benthos carnivore
Other Caridea	Prawns and shrimps	Macro-benthos carnivore
Nephrops norvegica	Norway lobster	Macro-benthos carnivore
Upogebia spp.	Burrowing prawn	Macro-benthos filter feeder
Macrura	Lobsters	Macro-benthos carnivore
Galatheidae	Squat lobsters	Macro-benthos carnivore
Munida sarsi	Squat lobster	Macro-benthos carnivore
Anomura	Squat lobsters and hermit crabs	Macro-benthos carnivore
Oxystomata	Crabs	Macro-benthos carnivore
Oxyrhyncha	Crabs	Macro-benthos carnivore
Cancridea	Crabs	Macro-benthos carnivore
Brachyrhyncha	Crabs	Macro-benthos carnivore
Brachyura	Crabs	Macro-benthos carnivore
Decapoda zoea	Young decapods	Meroplankton
Decapoda	Shrimps, crabs and lobsters	Macro-benthos carnivore
PYCNOGONIDA	Sea spiders	Macro-benthos carnivore
Unidentified CRUSTACEA		Macro-benthos carnivore
Sagitta setosa	Arrow worm	Meso-zooplankton carnivore
CHAETOGNATHA	Arrow worms	Meso-zooplankton carnivore
Ophiuroids	Brittle stars	Mega-benthos
ECHINODERMATA	Echinoderms	Mega-benthos
Ascidiae	Sea squirts	Macro-benthos filter feeder
UROCHORDATA	Tunicates and salps	Macro-benthos filter feeder
CEPHALOCHORDATA	Lancelets	Macro-benthos filter feeder
Gadus morhua	Cod	Demersal piscivore
Melanogrammus aeglefinus	Haddock	Demersal piscivore
Merlangius merlangus	Whiting	Demersal piscivore
Trisopterus esmarki	Norway pout	Pelagic planktivore
Norway pout post-larvae		Pelagic planktivore
Clupea harengus	Herring	Pelagic planktivore
Sprattus sprattus	Sprat	Pelagic planktivore
Ammodytidae	Sandeels	Pelagic planktivore
Pleuronectes platessa	Plaice	Demersal benthivore
Plaice eggs		Meroplankton

Scientific name	Common name	Life history guild
Solea solea	Sole	Demersal benthivore
Microstomus kitt	Lemon sole	Demersal benthivore
Limanda limanda	Dab	Demersal benthivore
Scomber scomber	Mackerel	Pelagic piscivore
Trisopterus minutus	Poor cod	Demersal piscivore
Gadiculus argenteus	Silvery pout	Pelagic planktivore
Unidentified Rocklings		Demersal piscivore
Gadidae	Unidentified gadoids	Demersal piscivore
Merluccius merluccius	Hake	Demersal piscivore
Clupeidae	Unidentified Clupeoids	Pelagic planktivore
Clupeoid post-larvae		Pelagic planktivore
Glyptocephalus cynoglossus	Witch	Demersal benthivore
Hippoglossus platessoides	Long rough dab	Demersal benthivore
Unidentified flatfish		Demersal benthivore
Anarhichas lupus	Wolf fish	Demersal benthivore
Maurolicus muelleri	Pearl-side	Pelagic planktivore
Argentinidae	Argentines	Pelagic planktivore
Callionymidae	Dragonets	Demersal benthivore
Trachurus trachurus	Scad	Pelagic piscivore
Sebastes viviparus	Norway haddock	Demersal piscivore
Echiichthys vipera	Lesser weever	Demersal benthivore
Gasterosteus aculeatus	Stickleback	Demersal benthivore
Syngnathus spp.	Pipe fish	Demersal benthivore
Triglidae	Unidentified gurnards	Demersal piscivore
Blenniidae	Unidentified blennies	Demersal benthivore
Crystallogobius linearis	Crystal goby	Pelagic planktivore
Gobiidei	Unidentified gobies	Demersal benthivore
Goby post-larvae		Demersal benthivore
Teleostei	Fish	
Flatfish larvae		Meroplankton
Other fish eggs		Meroplankton
Other fish post-larvae		Demersal piscivore

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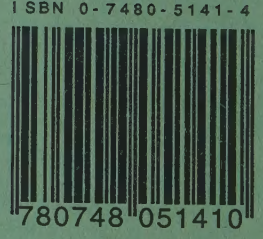
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